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WILLIAM H. BURT, *Editor*

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THE INTEGUMENT IN CANIDAE

BY MILTON HILDEBRAND

Observations on the mastology, dorsal tail gland, and nature and distribution of the vibrissae and hair bundles are here reported for the gray fox, and related to those of other canids as described in the scattered literature. Study skins and tanned hides examined are in the Museum of Vertebrate Zoology.

HAIR SLOPE (Fig. 1)

A uniform, uninterrupted, backward hair slope from nose to tail is approached in the long-bodied mustelids, and is usually considered to be the primitive condition, although the justification for this assumption has been questioned (Ludwig, 1921: 133, 143). In nearly all mammals this pattern becomes altered by changes that produce convergence points (tufts) or convergence lines (crests) where hair streams come together, and divergence points or divergence lines (feathers) where hair streams part. When two converging hair streams are deflected to right and left, a cross is formed.

The general hair-slope pattern is constant for each species, and individual variation is usually qualitative. Thus, a given convergence point is seldom absent, but its position is variable, and it may be simple or whorled in either direction. Minor changes in hair slope may take place during growth of the individual in at least some species, but there are no important age or sex differences (Niedoba, 1917: 216).

The hair-slope pattern of the dog has been described by several authors and is diagrammed by Ludwig (*op. cit.*: 128). Niedoba (*loc. cit.*) reports no differences which can be attributed to domestic breeds.

The hair slope of *Vulpes vulpes* was described by Toldt (1907–8). His account is difficult to equate with Ludwig's figure, but no differences are apparent except that he found a pattern of convergence and divergence lines on the tail which have not been described in other material.

An embalmed coyote was also found to conform to the general pattern of the dog. The inguinal region was without a divergence point, although this feature was observed on the study skin of a pup.

Hair slope was determined on five embalmed and four fresh gray foxes (*Urocyon*) except for the lower extremities and base of the ear. Some individual varia-

tion and asymmetry were noted, but a composite diagram for the gray fox would correspond with Ludwig's figure for the dog except in the lack of a divergence point and cross in the axilla. These features are probably usually present in the dog and coyote, and often absent in the gray fox. They might be found in a larger

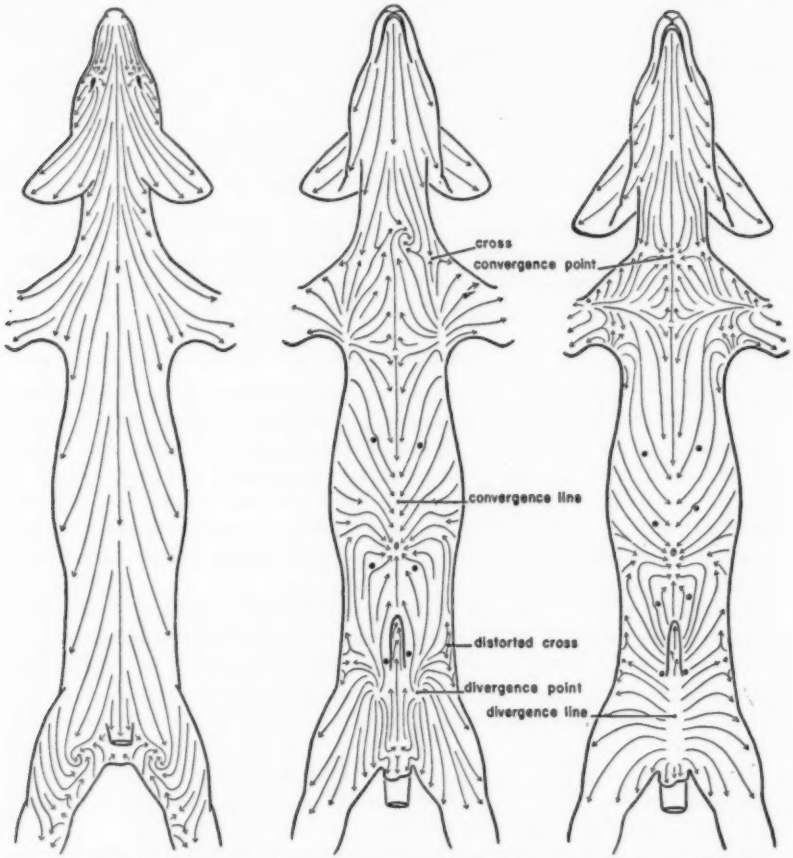

FIG. 1.—Hair slope on the dorsum of a gray fox (left), and hair slope and location of teats on the venter of a gray fox (center) and coyote (right).

series of foxes, and it is likely that any generic differences in hair slope to be seen among the Canidae would be bridged by individual variation.

Much attention has been directed to factors which might determine orientation of the hair follicles. Ludwig and Kül (1949) include useful reviews of thought on the problem, with citations to the literature.

HAIR ARRANGEMENT (Fig. 2)

The monograph by de Meijere (1894) is still foremost among many discussions of the arrangement of hair. On the well-furred parts of the bodies of many mammals each hair follicle becomes divided and produces a bundle of hairs. In the canids the bundles may be isolated, but are usually in groups of two to four or more; 3-bundle groups are by far the most frequent. The groups are oriented into somewhat irregular rows. The typical bundle consists of several wool- or underhairs and a single longer and stiffer guard- or over-hair. The guard-hair of the central bundle of a 3-bundle group is coarser than that of the lateral bundles.

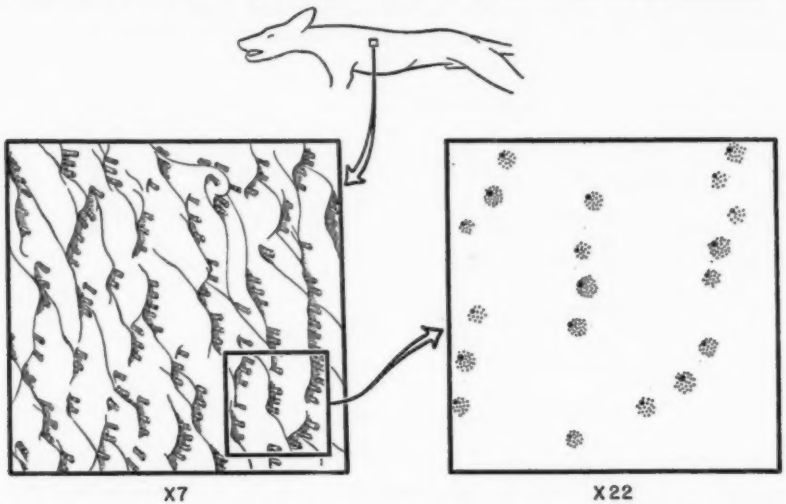

FIG. 2.—Magnified views to show hair pattern and surface sculpturing on the skin of the gray fox (hairs clipped).

Present theories on the origin of hair are too speculative to permit recognition of the primitive hair arrangement, however, the canid pattern is usually described as unspecialized.

J. C. H. de Meijere described the hair arrangement of *Canis familiaris*, *Canis* [= *Vulpes*] *vulpes* and *Canis aureus*. The arrangement of *Vulpes vulpes* was presented by Toldt (1907–8: Fig. 13), and Abe (1930) figured the pattern for Japanese and Korean species of *Canis*, *Vulpes*, and *Nyctereutes*. The hair arrangement is nearly identical in all of these animals.

The pattern is similar for *Dusicyon culpaeus* and *Canis latrans*, and differs in *Urocyon cinereoargenteus* only in having a somewhat greater number of hairs per bundle than is indicated for the canids cited in this literature.

SURFACE SCULPTURING OF THE SKIN (Fig. 2)

Toldt (1908) described the surface texture of the skin in *Vulpes vulpes* as being scale-like in profile. The hair bundles emerge between imbricated folds of skin

which are scarcely or not visible to the naked eye. There is no increased cornification of the skin at the folds. Hietel (1916) found an almost identical skin texture in the domestic dog.

Samples from the gray fox and coyote show the skin texture of these animals to conform well with drawings and detailed descriptions by the authors just named. Probably all canids have this kind of skin surface where the fur is thick. The scale-like pattern is most evident on the back. The folds are described as less plain on the more thinly-haired ventral surface in the dog and English red fox. This is true also for the gray fox, where those in the inguinal region are low, and the individual prominences are nearly fused into long parallel rows. Folds are nearly absent from the inguinal area of the more sparsely-haired coyote.

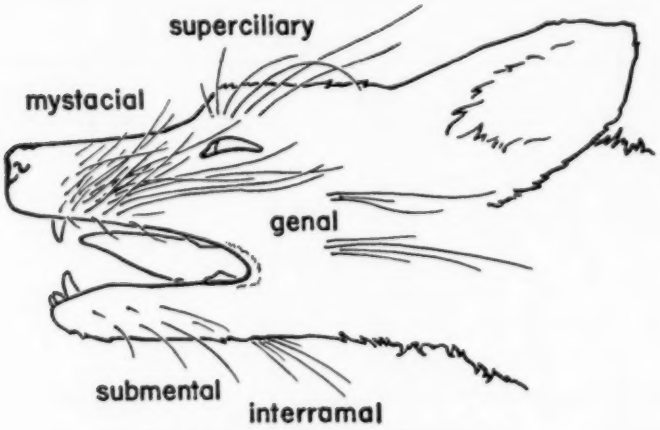

FIG. 3.—Cranial vibrissae of the gray fox.

A similar configuration of the skin surface is found in some other mammals, including the rabbit and seal, and has attracted attention because of the superficial resemblance to reptilian scales. Toldt believed that the skin folds of *Vulpes vulpes* are elevated by the hair bundles, and that the scale-like pattern which the folds assume results from grouping of the bundles. The folds would then bear no direct relation to true scales, although the arrangement of hair bundles might be derived from a former association with scales. A hair bundle pattern like that of the Canidae is present in some mammals having a smooth skin surface, so grouping of bundles does not necessarily cause imbrication. No condition has been described as intermediate between skin folds of the fox type and scales such as are found on the tail of *Myrmecophaga*.

CRANIAL VIBRISSAE (Fig. 3)

In his comprehensive report upon the vibrissae of mammals, Pocock (1914*a*) recognized five groups on the head, and considered the presence of all these on

one kind of mammal to be the primitive condition. The buccal group includes mystacial and submental parts and the genal group is often divided. The same author (1914*b*; 1927) described the cranial vibrissae of many canids and found them to be characterized by the presence of all groups except the subocular.

To relate structure to function, the longest vibrissae of the mystacial, superciliary, ventral genal, and interramal groups were measured on specimens of kit fox, gray fox, red fox, coyote, and wolf (Table 1). The lengths of the superciliary, ventral genal, and interramal groups may be directly related to body size, but are nearly the same length in all of the animals. The length of the mystacial vibrissae, on the other hand, bears an inverse relation to body size. They are about the same length as other cranial vibrissae in the wolf, but appreciably longer than the other groups in the foxes. It may be concluded that the cranial vibrissae are not important to the wolf, but that the mystacial vibrissae, and perhaps these only, are useful to the small foxes.

TABLE 1.—*Measurements of 543 cranial vibrissae (averages in mm.)*

SPECIES	MYSTACIAL	SUPERCILIARY	GENAL	INTERRAMAL	VARIATION
Kit fox	82	57	51	37	45
Gray fox	76	54	51	40	36
Red fox	72	60	60	37	35
Coyote	63	50	54	47	16
Wolf	57	51	61	53	6
Range of variation in length	25	10	10	16	

CARPAL VIBRISSAE

In his study of carpal vibrissae, Beddard (1902) found the organ to be characteristic of the Carnivora, but stated (p. 130) that, "I do not find it in the Dogs." Pocock (1914*b*) did not mention or figure carpal vibrissae on the feet of the Canidae. Toldt (1907–8) found them present in *Vulpes vulpes*.

Carpal vibrissae are present in the gray fox, and conform to Toldt's description. Seven fresh and embalmed specimens had one, two, or usually three vibrissae on each carpus. Vibrissae were found on all but four front feet of ten tanned skins selected at random from a large collection. The longest hair of each organ measured 20 to 45 mm.

Carpal vibrissae of the same length-range were found on skins of eight of twelve kit foxes (*Vulpes macroura*), and on each of three dried skins of *Dusicyon culpaeus*. Vibrissae were located on nine front feet of twenty tanned coyote skins. The longest measured 40 mm. Vibrissae could be detected on only three front feet of fifteen wolf skins.

Broken vibrissae are easily overlooked on a tanned skin unless stiff and of a contrasting color, and some must be lost in the tanning process. It would seem, however, that carpal vibrissae are sometimes absent in coyotes and wolves, and that when present they are relatively, and usually actually, shorter than those

of the foxes examined. This inverse relation to body size was noted by Beddard among other mammals.

TAIL GLAND (Fig. 4)

The gland in the dorsal skin of the tail on most canids was first described by Retzius in 1848 (Toldt 1907–8: 253). W. E. de Winton (1899), who was familiar with European and African genera, stated that the gland "was found in all the Canidae, with possibly the exception of *Lycaon pictus*." Pagenstrecher (1870: 249) did not find the gland in this species, and it is absent in the domestic dog (Toldt, p. 256). Seton (1923) figured the gland in six North American species. Kühlhorn (1940) described a dark spot on the tails of his genera *Cerdocyon* and *Lycalopex* (including *Dusicyon* and *Pseudalopex* of authors) which certainly represents the gland, and Cabrera and Yepes (1940: 125) found it present in *Pseudalopex* [= *Dusicyon*].

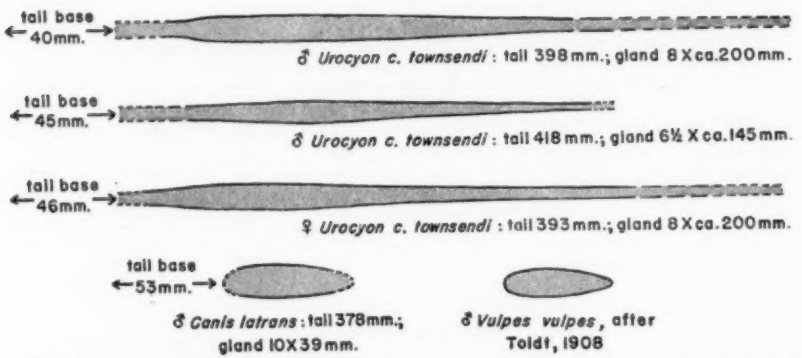
tail base
40mm.
♂ Urocyon c. townsendi : tail 398 mm.; gland 8 X ca. 200 mm.
tail base
45mm.
♂ Urocyon c. townsendi : tail 418 mm.; gland 6½ X ca. 145 mm.
tail base
46mm.
♀ Urocyon c. townsendi : tail 393 mm.; gland 8 X ca. 200 mm.
tail base
53mm.
♂ Canis latrans : tail 378mm.; gland 10X39mm.
♂ Vulpes vulpes, after Toldt, 1908

FIG. 4.—Variations in the dorsal tail gland of three gray foxes; outline of gland in a coyote and in a red fox.

Toldt described the gland, or "Violdrüse," of *Vulpes vulpes* in greater detail than is available for any other canid. It is an aggregation of modified sebaceous glands, producing a yellow fatty substance of unknown significance, but assumed to be related to recognition of species or individuals. The author has found nothing in references to the habits of the animal which lends support to this view. Toldt found much individual variation in more than 100 glands examined, but no sexual or seasonal size differences.

The guard-hairs on the glandular area are more rigid than elsewhere, and usually characteristically colored, often with black tips, whereas the underfur is reduced or absent. The extent of the gland can best be determined in fresh or embalmed material by trimming the fur to a length of about one-half inch, which affords maximum contrast between guard-hairs and underfur. The lateral margins of the gland are thus readily established, but the anterior and, particularly, the posterior limits are less clearly defined.

On six *Urocyon c. townsendi* the gland measured 6.5 to 8.0 mm. in width, and

about 125 to about 200 mm. in length, or one-third to one-half the total length of the tail. Its anterior limit was 40 to 50 mm. from the base of the tail. Grinnell, *et al.* (1937: 434, 435), described the black stripe on the upper surface of the tail as narrower in *scotti* than in *townsendi*. Seton (*op. cit.*) gave the length of the gland in two individuals from New York as only 3 and 4½ inches (76 and 114 mm., respectively). He examined only dried skins and did not trim the fur, hence his measurements may be too short. Even if correct, the gray fox has the longest tail gland described for any canid.

One coyote had a nearly oval gland measuring 10 x 39 mm., beginning about 50 mm. from the base of the tail. Its length was less than one-tenth that of the tail. Seton described a much narrower gland for a coyote from Saskatchewan.

MASTOLOGY (Fig. 1)

Of five male and three female gray foxes examined, seven had six teats and one had five. Several authors have reported that there are also three pairs of mammae in *Vulpes bengalensis*. (Pocock [1941: 129] said that this species is "Distinguished from *Vulpes vulpes* . . . by the presence of only two pairs of mammae instead of three . . .", but said [p. 111] of *Vulpes vulpes* that "usually at all events there are four pairs of mammae.") There were eight teats on a study skin of a *Vulpes macrotis* (No. 10584, Mus. Vert. Zool.), which agrees with the number in *Vulpes vulpes* and *Vulpes fulva*. A coyote also had eight teats, which is the number reported for *Speothos* (Flower, 1880).

Five pairs of mammary glands are found in *Lycaon* (Pagenstrecher, 1870: 249). Five pairs are most frequent in the domestic dog, but four or six pairs are often found. The number tends to be greater in the larger breeds (M. E. Miller, 1948: 86). According to several authors, *Cuon* has six or usually seven pairs of mammae; Pocock (p. 146) found eight pairs on one skin. Fourteen has been considered the maximum number of teats normal for a canid. Dr. J. R. Leekley, Biologist in charge of the U. S. Experimental Fur Station at Petersburg, Alaska, kindly counted the teats on fourteen pen-raised arctic foxes and reported six animals with twelve teats each and eight with fourteen each.

Irregularity in number of teats and asymmetry in their placement have been noted for many Carnivora, yet the figures presented in Table 2 indicate the expected rough correlation between litter size and number of milk glands. Litter size for the domestic dog cannot be listed independently of breed. Whitney (1927) reported average litters of three for toy dogs and up to nine for certain hounds and giant breeds. No figure was found for maximum litter size of breeds with lowest average number of pups. The record litter among dogs is 23. Seton (1925) gave the average arctic fox litter as four to five, with eleven as maximum. Dr. Leekley (letter) reported average litters of six to eight for pen-raised animals, with a maximum of fifteen. Braestrup (1941), in a detailed study of the arctic fox in Greenland, distinguished between "coast" and "lemming" foxes. Among other differences he reported maximum litters of ten for the former and 21 for the latter. No information is at hand on number of mammae in South American canids. The usual number of young for *Chrysocyon* is reported to be only two (Cabrera

TABLE 2.—*Litter size and number of mammae in the Canidae*

SPECIES	LITTER SIZE		AUTHORITY	MAMMAE, USUAL NUMBER	AUTHORITY
	Average	Maximum			
Urocyon cinereoargenteus	3.7	7	Sheldon, 1949	6	Hildebrand, MS.
Vulpes macrotis	4–5	7	Grinnell, *et al.*, 1937	8*	Hildebrand, MS.
Vulpes fulva	5.4	9	Sheldon, 1949	8	Turner, 1939
Canis latrans	5.7	9	Hamlett, 1938	8*	Hildebrand, MS.
Lycaon pictus	2–6	10*	Stevenson-Hamilton, 1912; Pagenstrecher, 1870	10*	Pagenstrecher, 1870
Canis familiaris	3–9 see text	?–23 see text	Whitney, 1927; 1937	10	Miller, 1948
Canis lupus	7	14	Young and Goldman, 1944	10	Young and Goldman, 1944
Alopex	4–8 see text	10–21 see text	see text	12–14	Leekley, letter
Cuon	6+	?	Blanford, 1888–91; Pocock, 1941	(12–)14	Pocock, 1941

* One observation.

and Yepes, 1940; F. W. Miller, 1930). Some South American canids may, like the gray fox, have only three pairs of mammary glands.

SUMMARY

The hair-slope patterns of the gray fox and coyote are figured and compared with those of the dog and English red fox as reported in the literature. Probably there are generic differences in pattern among the Canidae, but these may be bridged by individual variation.

Study of the gray fox, coyote, and culpeo, together with a survey of the literature, indicates that the arrangement of hairs into bundles and of these into groups is nearly identical for all canids so far studied.

The minute imbricated scale-like folds in the skin already described for the dog and English red fox also characterize the gray fox and coyote.

Analysis of four groups of cranial vibrissae in five North American canids indicates that none of these sense organs is important to the wolf, but that the mystacial vibrissae, and possibly these only, are useful to the small foxes.

The constancy of occurrence, relative length, and often the absolute length of carpal vibrissae varies inversely to the body size in the canids examined.

The dorsal tail gland is of variable length in the gray fox, but longer than heretofore described, and larger than in any other canid for which the gland is known.

The gray fox has three pairs of mammary glands. Single specimens of coyote and kit fox each had eight teats. The arctic fox has twelve to fourteen which equals the maximum canid number heretofore reported only for *Cuon*. The expected direct relation between number of teats and litter size is confirmed for nine canid species.

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TRAVEL, RANGE, AND FOOD HABITS OF TIMBER WOLVES IN WISCONSIN

By Daniel Q. Thompson

This paper is largely a food-habits study of the timber wolf (*Canis lupus*) in northern Wisconsin, but it also discusses travel, home range, and the predator-prey relationship between the wolf and the whitetail deer (*Odocoileus virginianus*). The food habits data presented here are based entirely on seasonal scat collections gathered from 1946 to 1948 on a wolf range in Oneida County, and from late winter through midsummer, 1948, on a similar range in Iron County.

STUDY AREAS

The wolf areas in Oneida and Iron counties lie within the Northern Highlands region in northern Wisconsin (Martin, 1932). The Oneida area is a region of low, irregular glacial moraine which is drained centrally by a small river. Approximately thirty per cent of the area is occupied by scattered swamps which vary in size from a few acres to a square mile in extent. These swamps present a varied appearance—some are open bogs of sphagnum moss (*Sphagnum* sp.), others support boreal forest stands of stunted black spruce (*Picea mariana*). Tamarack (*Larix laricina*) frequently appears as an associate with the small spruce. The less acid swamp pockets support mixed conifer stands running strongly to white cedar (*Thuja occidentalis*) and balsam fir (*Abies balsamea*). The low upland ground moraine stretching between the swamp areas originally supported highly productive stands of white pine (*Pinus strobus*) intermixed with northern hardwoods and hemlock (*Tsuga canadensis*) on the richer soils. The general soil type over this upland area is sandy loam.

This country was logged before the turn of the last century for the best grades of pine. Smaller cutting operations continued in later decades, leaving most of the upland area cut over before 1920. Early logging and the accompanying slash were followed by numerous fires which have left their scars on the old stumps on nearly all of the upland areas. Forest protection was almost nonexistent at this time. A fire succession of aspen (*Populus tremuloides*), pin cherry (*Prunus pennsylvanica*), and white birch (*Betula papyrifera*) grew up to occupy most of the upland, giving these sites much the same aspect as they have today.

The Iron County wolf area is broadly similar to the Oneida country, but several differences are apparent. The topography in this region is more sharply rolling, and swamp depressions occupy a smaller proportion of the land surface. As in Oneida County, the swamp sites are occupied by mixed conifer stands of spruce, tamarack, cedar, and fir. The upland soils in Iron County run to coarse gravelly loams which earlier supported relatively inferior stands of northern hardwoods and hemlock. Logging, therefore, did not begin in this country until comparatively recent times. The last major logging operation was completed in this area in 1941. The state forest protection system was well established and operating effectively during this period of cutting; hence fires were held to a

minimum, and most of the cut-over areas regenerated to second-growth hardwoods.

The Oneida and Iron County areas are isolated blocks of unsettled country offering upwards of 150 square miles each of suitable timber wolf habitat. Civilian Conservation Corps crews built a network of fire lanes throughout the areas during the late 1930's. These fire lanes are maintained by the Forest Protection Division of the Wisconsin Conservation Department and are closed to public travel.

WOLF TRAVEL AND RANGE

Over a period of three years I made a total of twenty-five trips into the Oneida country, at irregular intervals of from two weeks to two months. On seventeen of these visits timber wolf tracks, which were usually not more than a week old, often less, were noted. On one of the trips, when track sign was absent, howling was heard in the near vicinity. A crippled wolf served as a marked individual among the Oneida pack. Tracks of this animal showed the central toes missing from both rear feet and the inner toe missing from the right front foot. The left front foot had a normal number of digits, but field sketches and photographs showed that even this foot did not make a symmetrical spoor. The left outer toe was splayed outward, perhaps due to a trap injury.

Students of natural history have traditionally considered the travel route of a wolf pack to be a circuit, with the wolves covering the circuitous route every ten days or so. There was no such routine or consistent orientation observed in the movements of the Oneida wolves; their tracks indicated movement at one time or another in opposite directions on most of the main travel routes. A. de Vos (1950) observed similar irregularity in the movements of timber wolves on Sibley Peninsula, Ontario. The Oneida wolves spent a considerable portion of their time in, or at least made frequent visits to, a block of swamp islands that make up the center of their annual range. This area was considered to be a traditional denning location by Walter Rosenlof who has been trapping wolves in this region since 1933.

Fire lanes were preferred travel routes in all seasons. The wolves were also fairly consistent in using certain well-marked game trails as they passed through a sector en route to a more distant point. Consistency is used in the sense that the wolves traveled the same path; they sometimes moved in one direction, sometimes in the opposite. No distinct time pattern was noted in their movements.

Charles Otto of Tomahawk has tracked and hunted the Oneida wolf pack during the past 15 years; his observations, plus those of Rosenlof and my own field notes, indicate that these wolves occupied a winter range of approximately 150 square miles. Considering the average midwinter number of wolves in the Oneida pack to be three to four, this would give a density of approximately one wolf per 40 to 50 square miles. Stebler (1944) reports a group of four wolves in Upper Michigan using 260 square miles of range. This gives a somewhat lower density of one wolf per 65 square miles of range. On Sibley Peninsula, Ontario, de Vos (1950) estimated the summer density of wolves to be roughly one per six square

miles. It is difficult to compare wolf densities in the Lake States, where big game is more or less sedentary, with wolf densities in the Rocky Mountains where the wolves follow the altitudinal migrations of big game. However, it is interesting to note that the density estimates from Michigan and Wisconsin are not out of line with Cowan's (1947) findings in Jasper and Banff National parks. Cowan gives density estimates of one wolf for each 87 to 111 square miles on summer range and states that the wolf population compresses to approximately one wolf per ten square miles in winter.

Very little information was obtained on the travel habits and range of the wolves in the Iron County study area. Loggers reported three timber wolves using the fire lanes in the winter of 1947–48. One of these animals was hit by a car during this period. In the spring of 1948 I noted fresh tracks of two adult-sized wolves on this same stretch of fire lane.

Apparently the Iron County wolves made use of the fire lanes similar to that noted for the Oneida County group. The bulk of the scats collected from Iron County were taken from a six-mile stretch which seemed to be favored by the wolves. Deer-research workers on Pittman-Robertson Project 4-R located an active wolf den in this vicinity late in the winter of 1944–45.

SCAT IDENTIFICATION

Scat identification was one of the early problems encountered in this study. Timber wolf, coyote (*Canis latrans*), and red fox (*Vulpes fulva*) were resident on the study areas. In 25 trips, coyote tracks were noted on five occasions on the Oneida wolf runs. This compares with 17 occurrences of timber wolf tracks over the same routes. Coyote howling and barking was heard on one of the 25 trips. Previous field experience with the coyote and red fox showed that these species dropped considerably smaller scats than did the timber wolf. Fox scats were considered to be too small to cause any confusion, but it was considered probable that an overlap would occur between large-sized coyote scats and small-sized wolf scats.

A small collection of coyote scats had been made during my routine field assignments with the deer-research project. Twenty-five of these scats came from areas in Rusk, Sawyer, and Lincoln counties in which timber wolves were not resident. Diameter measurements of this limited sample were compared with measurements of 100 scats taken from the collections of the Oneida and Iron County wolf runs. Figure 1 presents frequency polygons constructed from these samples. The midpoint of each size class is actually a half-millimeter to the left of the point plotted on the polygon. For example, the measurements making up the 28-mm. class include all those from 26.5 mm. to 28.4 mm.; 27.5 mm. is, therefore, the true class midpoint. The positions of the two polygons indicate that in these samples, coyote scats overlap wolf scats approximately 5 per cent and wolf-run scats overlap coyote scats in the order of 10 per cent. The skewing of the wolf scat polygon to the left suggests that another factor is contributing to the main distribution. This skewing may be due to the influence of wolf pup scats or a contribution from coyote scats, or both. Thus, if timber wolf and coyote scats were encountered

on the fire lanes in an approximate 50–50 random distribution, scat identification by size alone would introduce the possibility of an objectionable error.

In describing scent posts and runways of timber wolves, Young and Goldman (1944) state: "As wolves pass over their runways, they stop at these posts, invariably voiding urine, and often feces as well." This describes rather well the situation I observed on the Oneida and Iron County wolf runs. Scat depositions by timber wolves on the Oneida and Iron County fire lanes were distinctive in that the droppings were concentrated on particular stretches of these lanes. My field experience with coyotes in Wisconsin indicates that they do not concentrate their droppings on favored stretches of trail or road, at least not to the extent

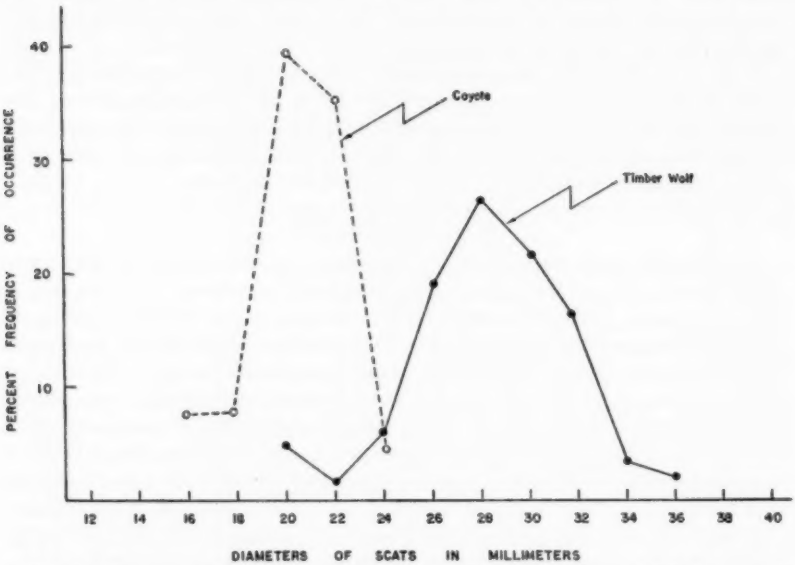

FIG. 1.—Frequency distribution of diameters of 25 coyote scats and 100 timber wolf scats.

observed on the Oneida and Iron County wolf runs. An exception to this general observation is the odd preference shown by coyotes for wooden bridges as "sign" areas. This peculiar trait was noted in Iron, Oneida, Forest, and Marinette counties, where accumulations of from four to ten coyote scats were noted lying on small logging-road bridges. Timber wolves showed no tendencies to leave sign on the wooden bridges in the Oneida and Iron County areas.

While making the field collections, I followed the policy of discarding all scats under 20 mm. in diameter. Scat fragments which were not in recognizable condition were also discarded. Later, after considering the data in Figure 1, I concluded that 24 mm. would be the lowest size limit one could safely use in separating coyote from wolf scats. Thus the food-habits data presented in this study are from scats of 24 mm. in diameter or larger.

SEASONAL FOOD HABITS

Table 1 presents the analysis of 435 timber wolf scats collected on the Oneida and Iron County wolf runs from the spring of 1946 to the summer of 1948. Whitetail deer was by far the most important food item in the wolves' diet during this period. This was indicated by the extremely high occurrence rate of 97 per cent in the total number of scats analyzed. Deer were widespread over both study

TABLE 1.—*Food items in timber wolf scats from Wisconsin, expressed as per cent frequency of occurrence per year*

MATERIAL IDENTIFIED	ONEIDA COUNTY			IRON COUNTY	TOTAL
	1946	1947	1948	1948	
Whitetail deer (*Odocoileus virginianus*)	93	99	99	100	97
Snowshoe hare (*Lepus americanus*)	5	5	9	2	5
Meadow vole (*Microtus pennsylvanicus*)	6	—	—	1	2
Red-backed vole (*Clethrionomys gapperi*)	3	—	—	—	0.9
Cottontail (*Sylvilagus floridanus*)	1	—	1	—	0.7
June beetle (*Phyllophaga* sp.)	—	1	—	—	0.5
Bird (egg shell)	0.6	—	1	1	0.5
Eastern chipmunk (*Tamias striatus*)	—	—	1	—	0.2
Grass (*Gramineae*)	24	32	13	28	25
Balsam fir (*Abies balsamea*)	12	11	6	11	11
Hemlock (*Tsuga canadensis*)	—	2	—	30	8
White cedar (*Thuja occidentalis*)	3	1	—	8	3
Leatherleaf (*Chamaedaphne calyculata*)	3	2	4	3	3
Black spruce (*Picea— mariana*)	2	—	1	5	2
Labrador tea (*Ledum groenlandicum*)	1	2	1	2	2
Pine (*Pinus* sp.)	1	1	3	1	1
Aspen (*Populus tremuloides*)	0.6	—	—	—	0.2
Goldenrod (gall) (*Solidago* sp.)	0.6	—	—	—	0.2
Rind (garbage)	0.6	—	—	—	0.2
Wrapping cord	0.6	—	—	—	0.2
Cotton cloth	0.6	—	—	—	0.2
Metal scraps	—	—	1	—	0.2
Number of scats	157	94	80	104	435

areas and existed in peak densities. The wolves were evidently able to kill deer at all seasons of the year with little difficulty.

Cowan (1947) found that ungulates appeared in 80 per cent of the 420 scats examined from Jasper and Banff National parks. Murie (1944) determined a somewhat lower (69 per cent) occurrence of ungulate prey in the annual diet of the Mt. McKinley wolves. Rodents made up the balance of the diet of both the Canadian and Alaskan wolves.

A brief comparison of big game species inhabiting these western and far northern ranges with those of Wisconsin is of interest at this point. The whitetail deer is the only remaining native ungulate in Wisconsin. This is in contrast to the

diverse big game populations of the mountain ranges. Caribou (*Rangifer arcticus*), white sheep (*Ovis dalli*), and moose (*Alces*) were available wolf prey species in Mt. McKinley National Park. In Jasper and Banff National Parks, elk (*Cervus canadensis*), mule deer (*Odocoileus hemionus*), and mountain goat (*Oreamnos americanus*) were present in addition to caribou, bighorn sheep (*Ovis canadensis*), and moose (*Alces*).

The above big game species are characteristically migratory to a greater or lesser extent, whereas in Wisconsin, annual whitetail deer movements are confined to local, winter concentrations in suitable conifer swamps. Wisconsin deer are vulnerable to wolf predation at all times of the year; they are protected only by their distance from local wolf pressure.

Significant seasonal variations in the diet of Wisconsin wolves occurred only in 1946 when they began to take rodents during summer and early fall. The occurrence of deer dropped to 85 per cent in a sample of 64 summer scats and to 90 per cent in 39 fall scats. Meadow vole (*Microtus pennsylvanicus*), snowshoe hare (*Lepus americanus*), and red-backed vole (*Clethrionomys gapperi*) made up the balance of the wolves' food items during these seasons.

Grass occurred in 25 per cent of the total scats examined. Usually this item appeared in trace quantities as a few blades or pieces of stem. In about one out of four of these occurrences, however, it was present as a sizable wad.

A host of miscellaneous items were found in the scats. Evergreen needles and twigs frequently occurred in trace quantities. These items were noted most frequently in the spring, summer and fall when the ground was free of snow. I think that this debris represents forest-floor litter which the wolves pick up as they feed on the kill. It is also possible that some of this vegetable material is ripped from the paunch of the deer as the wolves tear at the carcass. However, Wisconsin trappers are in general agreement that wolves do not normally eat the paunch of a deer kill. These observations are substantiated in scat analysis by the most frequent occurrence of needles and twigs during the green season when deer are normally feeding on herbaceous forage.

FAWN PREDATION

In the summer, a wolf scat made up of fawn hair can usually be distinguished from one of adult hair by the difference in texture between the two hair masses. Frequently, summer scats will contain tiny hoofs or recognizable tooth and bone fragments which identify the prey as a fawn. In some late May and early June scats, the thick, white hairs of the winter coat appear intermixed with incoming summer pelage, thus conspicuously identifying an adult. The gross distinction between fawn and adult pelage holds good until approximately September first, when the autumnal molt begins. The fawns now begin to assume their first winter coat, which is not conspicuously different from the winter coat of the adult.

Deer remains occurred in 141 of the 148 scats that I collected during the summer periods (May 21 to August 31) of 1946, 1947, and 1948. Forty-five per cent of these occurrences were fawn, 50 per cent were adult, and five per cent were unclassified as to age. Considering that fawns make up less than half (approximately

one-third) of the summer population, it would seem that the wolves preyed upon a slightly higher proportion of fawns than adults.

My field observations indicate that fawns are relatively inactive in late May and early June. Fawns encountered during this period are usually bedded down and show little inclination to move when approached. By late June this situation is changing; fawn tracks become evident on the fire lanes. The young are less frequently encountered than adult deer, but they are now becoming active and will move about with the mother for the rest of the summer.

In 1948 an attempt was made to compare the vulnerability of fawns during the secluded period with their vulnerability later in the summer. All scats collected (55) between May 21 and June 26 were considered referable to the period when fawns were secluded. Scats collected (13) after June 26 were considered referable to the active period. Obviously these dates only roughly coincide with the phenology of fawning. I have considered the peak in fawning in northern Wisconsin to occur in the last week in May and the first two weeks in June.

The occurrence of fawn and adult remains in the 55 scats collected during the early summer period were as follows: fawn, 42 per cent; adult, 56 per cent; unclassified, two per cent. These data indicate that wolves began to prey on fawns in the first few weeks following the peak of fawning.

The following values were obtained from 13 scats collected during the late summer period: fawn, 61 per cent; adult, 31 per cent; unclassified, eight per cent. The sample size is very small, but it is interesting to note the trend in increased vulnerability of fawns in comparing the early and late summer samples.

WOLF PREDATION IN RELATION TO AVAILIBILITY OF PREY SPECIES

Whitetail deer (*Odocoileus virginianus*).—In the winter of 1941, range-survey crews of Pittman-Robertson Deer-Research Project 4-R checked seven deer yards within the Oneida County wolf range. Their reports (unpublished) showed that white cedar, an important winter deer food, was browsed out of all the yards examined. Other important browse species, such as red maple (*Acer rubrum*), mountain maple (*Acer spicatum*), hard maple (*Acer saccharum*), and red-osier dogwood (*Cornus stolonifera*), also showed excessive browsing by deer. Balsam fir and speckled alder (*Alnus incana*), inferior forage species which are normally unbrowsed in Wisconsin, were reported as lightly browsed in several of the yards checked. My own field notes of 1946 to 1948 show that the Oneida study area range has remained in this near-critical condition. P-R Deer-Research Project notes and my own field observations show that a similar range history has occurred in the Iron County wolf study area. Thus, range conditions indicate that the deer herds of the Oneida and Iron County wolf areas developed symptoms of over-population in the same manner as did Wisconsin deer herds which were free of wolf pressure. This relationship will be discussed in a later section of this paper.

Deer tracks were by far the most common sign encountered on the fire lanes in the wolf areas. On the more moist slopes, the fire-lane shoulders produced stands of forage which under the protection of snow remained in green condition

into the winter. White clover (*Trifolium repens*), cinquefoil (*Potentilla* sp.), and the basal rosettes of unidentified forbs made up the bulk of this growth. Deer were repeatedly observed pawing in snow depths as great as 11 inches for this forage. The frequent use of these lanes by the wolves apparently did not discourage the deer from seeking this food.

In order to compare the abundance of each species encountered on the fire lanes, sight-record tallies were made of deer, hares, and porcupines (*Erethizon dorsatum*). Table 2 shows these tallies as individuals encountered per 100 miles of travel. Observation-miles for these tallies were contributed from foot and car travel on the closed fire lanes within the wolf areas. This sort of tally is subject to a variety of errors which make direct comparisons of abundance between species very misleading. Hares, for instance, are not as conspicuous as deer and make very little noise as they speed away through the undergrowth. In contrast to hares, deer are conspicuous, noisy, and inclined to "jump" at far greater distances from the observer. Hence, one cannot make direct comparisons of abundance between these two species on the basis of sight-record tallies. These tallies do, however,

TABLE 2.—*Flushing rates on prey species in 401 observation-miles on wolf runs*

YEAR	COUNTY	INDIVIDUALS ENCOUNTERED PER HUNDRED MILES		
		Deer	Hare	Porcupine
1946	Oneida	20	0.6	not recorded
1947	Oneida	32	6	not recorded
1948	Oneida	31	10	26
1948	Iron	24	7	11

indicate relative abundance of the same species in comparing two or more areas. They also indicate population trends over a period of years.

The encounter tallies on deer indicate that the populations in the Oneida and Iron County study areas were of the same order of density during the period of this study.

Snowshoe hare (*Lepus americanus*).—Wisconsin Conservation Department kill statistics indicate that the last period of great abundance of snowshoe hares was in 1931 and 1932 when state-wide annual kills were estimated to be approximately 630,000. For the period of the present study, annual kill estimates are as follows: 1946—57,000; 1947—64,000; 1948—177,000. The trend of snowshoe hare flushing rates in the Oneida area (Table 2) from 1946 to 1948 was in the same direction as the trend of the statewide kills. This suggests that the hares were in comparatively low densities at the beginning of the food-habits study and in the next two years increased to moderately high densities.

During this same period the occurrence of snowshoe hare in the Oneida wolf scats increased insignificantly from 5 to 6 to 8 per cent. This would indicate that the wolves did not respond greatly to a moderate increase in hares. Cowan (1947) found a similar rate of occurrence (7 per cent) of hare remains in the annual diet of the wolves of Jasper and Banff National parks. He states that the snowshoe hare was common locally in Athabaska Valley during the period of his study, but

had not displayed an irruptive increase since 1915. Murie (1944) reported snowshoe hares as extremely scarce during his field work in Mt. McKinley National Park (1939–41). This scarcity was reflected in the occurrence of only three items of hare remains in the 1174 scats collected during his study. However, Murie believed that if hares were plentiful they would probably supplement the food supply of wolves considerably. Other observers (Preble, 1908; Olson, 1938; and Stanwell-Fletcher, 1942) have reported wolves using snowshoe hares as a substantial part of their diet.

Cottontail rabbit (*Sylvilagus floridanus*).—On three occasions cottontail rabbit remains appeared in small quantities in Oneida wolf scats. Oneida County lies at the northern edge of the cottontail's range in Wisconsin, and this rabbit occurs in very low densities in this region. Iron County lies north of the normal range of the cottontail and remains of the rabbit did not occur in the scats collected from this area.

Microtines.—In late summer and fall of 1946, I observed an abundance of meadow voles (*Microtus pennsylvanicus*) in the grass cover bordering the Oneida fire lanes; one had only to walk a few rods in the grass to see one scurrying along a half-exposed runway. Meadow voles occurred in nine out of 103 scats collected during the summer and fall of this year. The wolves had evidently taken occasional advantage of their abundance, for this is the highest rate of occurrence of voles in scats collected during the study. Meadow voles were usually supplementary to some other food item; only three of the scats were made up entirely of these small rodents.

Red-backed voles (*Clethrionomys gapperi*) appeared as supplements in four of the 103 scats considered above. These are the only occurrences of this woodland vole in the Oneida or Iron County wolf scats.

Microtines appeared in only 3 per cent of the total scats collected. This is comparable to Cowan's (1947) findings of 2 per cent voles (*Microtus* sp.) in the annual diet of the Rocky Mountain wolves.

Murie (1944) found a somewhat higher utilization of voles and lemmings by the Mt. McKinley wolves. Here, *Lemmus*, *Microtus*, and *Clethrionomys* occurred in 6 per cent of the total scats collected. Murie observed that the wolves preferred to feed on larger game animals and did very little mousing when caribou were plentiful.

Porcupine (*Erethizon dorsatum*).—Porcupines were commonly encountered along wolf runs. Pin cherry (*Prunus pennsylvanicus*) is one of the preferred fall and winter foods of this big rodent. Pin cherry is an associate with quaking aspen and white birch in many of the fire successions of northern Wisconsin. Considering pin cherry as a range indicator, one would judge that porcupines were over populating the Oneida range. In some stands nearly every pin cherry over two inches in diameter had been girdled by porcupines. The outer bark of these trees had been stripped back to expose the highly palatable inner bark layers.

Despite their abundance, no traces of porcupines appeared in the scat-analysis food items. Both Murie (1944) and Cowan (1947) found porcupine remains in approximately one per cent of the scats they analyzed.

Beaver (*Castor canadensis*).—Beaver were comparatively scarce in the Oneida

and Iron County areas during the period of this study and did not appear in the food items used by the wolves.

THE EFFECTS OF WOLF PREDATION ON THE DEER

Several lines of evidence were examined in an attempt to appraise the effects of the wolves on the deer population in the Oneida County area. "Jack-lighting" was used in an effort to gather a series of sex-age tallies from within the wolf range, but the samples obtained were too small to be reliable.

The deer census files of the Civilian Conservation Corps were examined at the Forest Protection Division Headquarters, Tomahawk, Wisconsin, in an effort to gather density data for the Oneida wolf range and the adjacent deer range which was free from wolf pressure. Deer-census data were available from two drive areas which were located within the wolf range. Two additional CCC census areas which lay outside of the normal hunting range of the wolves were chosen as control areas. The value of these data is somewhat reduced by the fact that the last of these drives predates the beginning of the present study by six years. However, interviews with local trappers and wolf hunters have established rather well the presence of a small group of timber wolves in the Oneida County range during the period spanned by the deer drives. Thus, I concluded that the CCC data were well worth examining as an insight into the effect of the wolves on the local deer herd.

The average numbers of deer per section as determined by November and December census drives within the wolf range were as follows: 1935—13, 1936—10, 1937—14, 1938—14, 1939—16, 1940—31. Similar census drives on areas outside of the wolf range produced the following average population densities: 1935—10, 1936—9, 1937—15, 1938—23, 1939—30, 1940—34. These data strongly suggest that the period 1935 to 1940 was one of general increase in deer densities in this section of Oneida County. The drives inside the wolf range may indicate that the rate of increase was not so great here as outside the wolf range. However, the rate of increase was of the same order, roughly from 10 deer per section in 1935 to 30 deer per section in 1940.

The similarity in deer population behavior on the Oneida wolf range and wolf-free range agrees with the inference drawn from range conditions within the wolf area; namely, that the timber wolves at present densities did not prevent an overpopulation of deer from developing in the past two decades. Browse tallies and deer-yard inspections in the wolf range in Iron County reveal very similar conditions.

One must consider in this conclusion that neither the wolves nor the deer represent a normal population. Trapping and hunting have continually harassed the wolves and kept their numbers to a critical minimum. The primitive deer habitat has been radically altered by man's activities; most of these changes favored a great increase in deer numbers.

STATUS OF THE TIMBER WOLF IN WISCONSIN

It was not within the scope of this study to make an extensive survey of Wisconsin timber wolf range. However, as field work progressed, certain local land-

use problems and relationships became evident which, I believe, critically apply to the Wisconsin timber wolf range in general and indicate the precarious status of this species in much of the Lake States area at the present time.

Timber wolves once ranged over all of Wisconsin. They have been gradually extirpated with the northward advance of settlement. Resident wolves are now confined to less than a dozen suitable areas of undeveloped, cutover forest land. The Oneida and Iron County study areas described earlier in this paper are examples of this habitat. These areas have several features in common. Lack of good fishing water has discouraged the development of commercial resorts. Soils were often too rough or poor to attract even the hardiest of early backwoods farm settlers; more recently rural zoning by county governments has also prevented the development of scattered submarginal farms. In some areas inferior stands of virgin hardwood have been until recent decades unprofitable for logging companies to exploit.

Without settlements or commercial resorts, there was no demand for road construction in the areas; hence the only travel routes were old logging-railway grades and tote roads. This situation changed in the late 1930's when an extensive program of fire-lane construction was undertaken by the Civilian Conservation Corps. During this same period, the U. S. Forest Service began a land-purchase program which established two national forests in Wisconsin. Federally supervised Civilian Conservation Corps camps built a network of fire lanes through the new purchase areas. The federal fire lanes were less extensive than the state system and in general were constructed with a greater investment per mile of grade, creating a network of graveled roads which were open to public travel. This has reduced the value of the national forest areas as timber wolf habitat.

Quite in contrast, the state-controlled fire lanes have for the most part been closed to public travel, since it would have been impossible for the state forest-protection division to maintain the large mileages of fire lane as public thoroughfares without a considerable increase in manpower and equipment. This administrative contingency has worked to the advantage of the timber wolf by preventing easy access by trappers and wolf hunters to the heart of much of the remaining wolf habitat in Wisconsin.

There is, however, continued pressure on town government officials to declare sections of fire lanes as town roads. In some instances these demands are justifiable in terms of the general public's transportation needs, but some of this pressure is from small local interests, such as resorters, sportsmen, and trappers who are anxious to have easy access by car to a few remaining natural areas. In the timber wolf range, the opening of each new section of closed fire lane area to public travel has jeopardized the existence of the wolves. Trappers then drive into an area with a carload of traps where formerly they had to hike in with only as many traps as they could carry in a packsack. These open roads also allow veteran wolf hunters to work their dog packs much more effectively. If this trend continues, the timber wolf will eventually be extirpated from Wisconsin.

In Wisconsin, with the exception of a few minor lapses, bounties have existed on the timber wolf since the beginning of statehood. The present bounty offers a $20 reward for the taking of a "mature" coyote or timber wolf of either sex. Pups

of either species bring $5 apiece from March to October. The bounty has persisted despite the fact that, in Wisconsin, timber wolves are for the most part too far removed from settlements to inflict any appreciable damage on livestock. In Oneida County the wolves occasionally ranged to within a few miles of a farm settlement along the south edge of their range; but here, as is usual on dairy farms, livestock are confined to small pastures near the farm dwellings and are, therefore, not likely to be vulnerable to wolf predation.

Ecologists are in general agreement that we should not exterminate a native species. Viewing the status of the timber wolf in Wisconsin from this point, I conclude that action should be taken within the next few years to protect this species. The most obvious recommendation to make would be that we remove the bounty on "wolves." This recommendation was tested from July, 1943, to March 1945, when the bounty was suspended on both the coyote and the timber wolf. This action drew a very unfavorable public response, at least from the relatively small segment of the populace that expresses its opinion on wildlife problems. As a result, the bounty was restored in 1945. During this bounty-free period, there were no indications that wolf hunting for sport in any way diminished, the Wisconsin Conservation Department data even suggested that the coyote and timber wolf kill increased.

We can learn two things from this unfortunate episode. First, we cannot abruptly remove the traditional bounty on timber wolves and coyotes without offering a substitute predator control system. This again raises the problem of public confusion as to the identity of coyotes (brush wolves) and timber wolves. Any economic damage inflicted by the more widespread and adaptable coyote will stir public resentment which will fall on the timber wolf as well as the coyote.

Secondly, we cannot assume that removing the bounty on coyotes and timber wolves, much less on timber wolves alone, will adequately protect the timber wolf. Hunters with trained wolf hounds are primarily interested in pursuing wolves as a sport; the loss of revenue from bounties would little discourage their activities. This then emphasizes the importance of maintaining suitable habitat for the timber wolf. The gradual shrinkage of wilderness habitat in Wisconsin increases the vulnerability of timber wolves to trapping and hunting pressure and will eventually lead to the extirpation of this species within the state boundaries. This assumes that the timber wolf will continue to exhibit an inability to adapt itself to semi-settled conditions, which has characterized its withdrawal from forest areas to the south within the past few decades.

Thus, the continued existence of the timber wolf in northern Wisconsin depends on our ability to maintain suitable wilderness habitat. These areas would need to be at least 150 square miles in size to harbor a wolf family. Refuges, locked fire lanes, and strict adherence to rural zoning represent the best efforts that we can make at present. With this protection the timber wolf will probably be able to persist in the face of present hunting and trapping pressure for another decade. This might allow us time enough to establish a system of selective predator control, which would lift some of the bounty pressure from the wolf's head. Some form of legal protection is probably already necessary to perpetuate the timber

wolf in Wisconsin; but public opinion today is, of course, unprepared for such an extension of conservation thinking.

SUMMARY

A food-habits study was conducted on two northern Wisconsin timber wolf ranges between 1946 and 1948.

The movements of the wolves occupying the Oneida County range were observed to be quite irregular in both direction of travel and in frequency of visiting any particular section. The wolves were fairly consistent, however, in using the same stretch of trail or road as they passed through a section.

Winter observations on these wolves indicated that they ranged over an area of approximately 150 square miles.

Whitetail deer remains occurred in 97 per cent of 435 scats collected from 1946 to 1948; deer were the staple food of the wolves in all seasons of the year. Fawn remains occurred in approximately half of the summer scats. Rodents and lagomorphs, chiefly snowshoe hare, occurred in 9 per cent of the total scats.

A slight shift in the wolves' diet occurred during an abundance of voles in the late summer and fall of 1946 when rodents (chiefly voles) appeared in 15 per cent of the scats.

Range conditions showed that an over-population of deer existed on both the Oneida and Iron County study areas.

Census data from Civilian Conservation Corps deer drives indicated that deer densities on the Oneida wolf range and on nearby wolf-free range increased in approximately the same order of magnitude during the period 1935 to 1940. The order of increase was roughly from 10 deer per section in 1935 to 30 deer per section in 1940.

The small group of wolves occupying the Oneida County range were apparently ineffectual in preventing an overpopulation of deer from developing. A similar wolf-deer relationship is indicated for the Iron County wolf range.

Timber wolves once ranged over all of Wisconsin. They have been gradually extirpated with the northward advance of settlement and are now confined to the remaining blocks of wilderness area in the northern portion of the state.

To prevent the extirpation of the timber wolf from Wisconsin, it will be necessary to maintain areas of at least 150 square miles as wilderness habitat. Such areas could be opened to deer hunting, logging, and other normal forest land-use activities without harassing the wolves.

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SIZE CHARACTERISTICS OF THE SACRAMENTO VALLEY POCKET GOPHER (*THOMOMYS BOTTAE NAVUS* MERRIAM)

BY MILTON A. MILLER

Size and shape, important attributes of individuals making up a species, have significant implications in many lines of investigation. In taxonomy, body size and proportions of parts are commonly used as diagnostic characteristics. In ecology, size may be associated with particular environmental conditions. Davis (1938) and Hall (1946), for example, have shown a relationship between size in pocket gophers and soil and altitude—small kinds with little or no secondary sexual dimorphism live at higher altitudes and in thin soils, whereas larger kinds with greater sexual dimorphism are found at lower altitudes and in deeper soils. Hall (*op. cit.*) also reports a north-to-south size gradient in *Thomomys bottae* in Nevada—the largest animals occurring in the north, the smallest in the south. This, presumably, is in accord with Bergmann's rule that, in warm-blooded species, large size tends to prevail in cool parts of the range. Tryon (1947) demonstrates an association between average weights of adult specimens of *T. talpoides* and the soil and amount and type of vegetation on three mountain meadows from which samples were taken—the better the meadow, the larger the gophers. In physiology, size is related to many processes such as metabolism, growth, and reproduction. In *T. b. navus*, for example, Miller (1946) found that

fertility in females is associated with size, increasing with weight (age) to an optimum and then possibly declining, and that small, young females were largely responsible for a summer breeding peak in irrigated alfalfa fields. In economic research, information on size of a pest species is useful in such practical matters as estimating lethal dosages of poison (usually expressed as amount of poison per unit body weight), determining amounts of bait needed, and selecting proper sizes of traps.

As with many other quantitative characteristics, size varies within populations, and may intergrade between related taxonomic groups. To establish the size parameters of a species, therefore, adequately large and representative samples from various localities within its geographic range are required. Perusal of taxonomic literature on many groups of animals, however, indicates that few authors apply adequate statistical treatment to their data. Most modern taxonomists now recognize that averages of even a small topotype series are more reliable and useful than measurements of but a single "type specimen" (which may or may not be typical) and attempt to convey some idea of size variation, usually by giving minimal and maximal measurements. But rarely does one find estimates of reliability (as standard errors) applied to averages, and too often (as a probable consequence) statistical significance is attributed to differences that might be due to chance. Moreover, standard or even average deviation are suggested as better expressions of size variation than the extremes.

Several relatively recent publications on pocket gophers have included size data for various species based on fairly large collections. Smith (1940) gives weight data on 104 adult specimens of *Thomomys talpoides fuscus* from Montana. Tryon (1947) reports average weights of 106 adults and 12 juveniles of *T. talpoides* from Montana, Ingles (1949) records mean and extreme weights of 79 adults of *T. monticola* from California, and Moore and Reid (1951) give length and weight characteristics of *T. talpoides quadratus* from Oregon. Also useful are observations on growth as given in the last three publications cited above and by Miss Bernice Sagal (1942) who measured growth of a male and female of *T. bottae bottae* from birth (in captivity) to 39 and 53 days of age, respectively.

The present report on size characteristics of the Sacramento Valley pocket gopher (*Thomomys bottae navus* Merriam) is based on post-mortem measurements of nearly 2300 specimens taken from the University of California farm lands at Davis. About half of these were obtained by Tracy I. Storer and several other members of the Division of Zoology over a 10-year period (1932–1941), and the remainder by the author with the assistance of Miss Virginia Dohrmann over a continuous 14-month period beginning in April, 1944. The latter collection was made primarily to obtain data on reproductive cycles (Miller, 1946).

Trapping was the principal collecting method, but many gophers were flooded out of their burrows and killed during irrigation of fields. Some specimens were recovered after death during field tests with poison baits. Numbers of gophers collected and sex ratios in each season of the year are given in Table 1.

Most specimens were collected from cultivated land, especially from irrigated alfalfa fields which generally harbor dense gopher populations. Moreover, the

moist soil in irrigated fields facilitates trapping. Relatively few gophers were taken from non-irrigated fields during the long dry season (summer and fall) when the ground became so hard that probing for gopher tunnels and excavating sites for gopher traps was difficult. During the rainy season, however, as soil conditions for trapping improved, proportionately more gophers were collected from non-irrigated areas.

To minimize post-mortem changes, the animals were autopsied within a day or two after death, usually on the day they were collected. Measurements included: (1) body weight; (2) total length, from snout to tip of tail; (3) head-body length, from snout to base of tail; (4) tail length, from its junction with the sacrum to tip of last caudal vertebra; and (5) hind foot length, from heel to claw tip of longest digit. Biometric data on reproductive organs were also recorded. If embryos were present, their number, lengths (crown–rump), and weights were taken. Statistical procedures were applied to these data. The valuable aid of Mrs. Shirley Downie with the computations is here acknowledged.

TABLE 1.—*Numbers and sex ratios of Thomomys bottae navus collected principally from irrigated alfalfa fields at Davis, Yolo County, California, 1932–1945*

SEASON	NUMBER		SEX RATIO ♂♂:100 ♀♀ ± S.E.
	♂♂	♀♀	
Winter (Dec.–Feb.)	421	606	69.5 ± 1.4
Spring (March–May)	260	331	78.5 ± 1.7
Summer (June–Aug.)	150	178	84.3 ± 2.0
Fall (Sept.–Nov.)	155	162	95.7 ± 1.1
All seasons	986	1277	77.2 ± 0.9

The principal size parameters are given in Table 2 and Figs. 1–2. With the collecting methods used, gophers from weaning age to the presumed upper limits of size were obtained. The ranges for males were 27 to 274 grams in weight, 123 to 305 mm. in total length, and 79 to 230 mm. in body length. Females ranged between 32 and 195 grams in weight, between 135 and 246 mm. in total length, and between 95 and 188 mm. in head-body length. Nestling gophers are not represented in the collection. Between the above-mentioned limits, however, it is assumed that a fairly representative, if not completely random, sample was obtained.

There is presumptive evidence that trapping is somewhat selective in that the smallest and largest animals, males, and pregnant females may not be as fully represented in trap collections as they are in nature. The traps used (Macabee and similar types) theoretically would miss small gophers whose body length is less than the distance (65 to 80 mm.) between the trigger plate and jaws of the trap. This assumption is supported by the fact that the smallest gophers trapped were caught by the posterior end of the body or even by the tail. Large gophers, on the other hand, may be "trap-wise," or if insecurely caught may be able to pull

themselves free as evidenced by finding occasional sprung traps with only a bit of skin, hair, or an amputated foot.

A sex ratio in the collection of only 77.2 males per 100 females (Table 1) raises the question whether males are more wary than females, or whether there is a natural preponderance of females in the population. There is no ready answer, but it is relevant that Smith's (1940) collection of 104 specimens of *Thomomys talpoides fuscus* also contains less males than females with a sex ratio of 89.1 males per 100 females. The statement that pregnant females may be less fully repre-

TABLE 2.—*Size parameters of Thomomys bottae navus collected principally from irrigated alfalfa fields at Davis, Yolo County, California*

CHARACTERISTIC		NUMBER EXAMINED	MEAN ± S.E.	MODAL CLASS	RANGE	STANDARD DEVIATION σ ± S.E.	COEFFICIENT OF VARIABILITY C.V. ± S.E.
Weight (in grams)							
All	♂♂	986	153.2 ± 1.43	180–189	27–274	45.0 ± 1.02	29.4 ± 0.72
All	♀♀	1277	112.0 ± 0.73	120–129	32–195	26.1 ± 0.52	23.3 ± 0.48
Virgin	♀♀	315	87.8 ± 1.22	90–99	32–158	21.8 ± 0.87	24.8 ± 1.05
Pregnant	♀♀	149	133.3 ± 1.67	130–149	90–182	20.4 ± 1.18	15.3 ± 0.88
Recently parous	♀♀	135	125.5 ± 1.72	120–129	85–195	20.0 ± 1.22	15.9 ± 1.00
Parous	♀♀	414	117.8 ± 0.86	120–129	66–195	17.6 ± 0.61	14.0 ± 0.52
All classified	♀♀	1013	111.8 ± 0.82	120–129	32–195	26.0 ± 0.58	23.2 ± 0.54
Total length (in mm.)							
All	♂♂	985	227.2 ± 0.71	230–239	123–305	22.3 ± 0.50	10.1 ± 0.23
All	♀♀	1267	206.3 ± 0.42	210–219	135–246	14.9 ± 0.30	7.2 ± 0.14
Body length (in mm.)							
All	♂♂	987	161.9 ± 0.54	165–169	79–230	17.1 ± 0.38	10.6 ± 0.24
All	♀♀	1277	147.9 ± 0.33	150–154	95–188	12.0 ± 0.24	8.1 ± 0.16
Virgin	♀♀	314	138.2 ± 0.70	140–144	95–168	12.5 ± 0.50	9.0 ± 0.36
Pregnant	♀♀	149	153.1 ± 0.73	150–154	127–174	8.9 ± 0.52	5.8 ± 0.34
Recently parous	♀♀	135	153.7 ± 0.78	155–159	123–188	9.0 ± 0.55	5.9 ± 0.36
Parous	♀♀	495	152.0 ± 0.39	150–159	112–178	8.7 ± 0.28	5.7 ± 0.18
Tail length (in mm.)							
All	♂♂	985	65.3 ± 0.27	60–64	40–89	8.4 ± 0.19	12.8 ± 0.29
All	♀♀	1267	58.2 ± 0.18	55–59	35–79	6.5 ± 0.13	11.1 ± 0.22
Hind foot length (in mm.)							
All	♂♂	137	27.1 ± 0.20	28	19–38	2.4 ± 0.14	8.7 ± 0.53
All	♀♀	168	25.2 ± 0.13	25	20–29	1.7 ± 0.10	6.6 ± 0.36

sented in trap collections than in the natural population is supported by previously reported data (Miller, 1946: 351), showing that of 135 pregnant females taken, only 21 had large embryos, 43 had medium-sized embryos, and 81 had small embryos, indicating that as pregnancy advances females are less likely to be caught.

Frequency distributions of weights and lengths (Figs. 1 and 2) and means for these measurements (Table 2) clearly demonstrate a marked sexual dimorphism in the Sacramento Valley pocket gopher. Males, with a mean weight of 153.2 grams, outweigh females by 41.2 grams on the average, while the modal class of males (180–189 grams) is 60 grams heavier than that of females (120–129 grams).

In total length males exceed females by nearly 21 mm., on the average, the modal difference being about the same. Sexual dimorphism is also shown in lengths of hind foot and tail.

Typical dimensions of *Thomomys bottae navus* in the locality of Davis may now be established as follows. The "mean male" weighs 153.2 grams, is 227.2 mm. in total length with a tail 65.3 mm. long and a hind foot length of 27 mm.; while

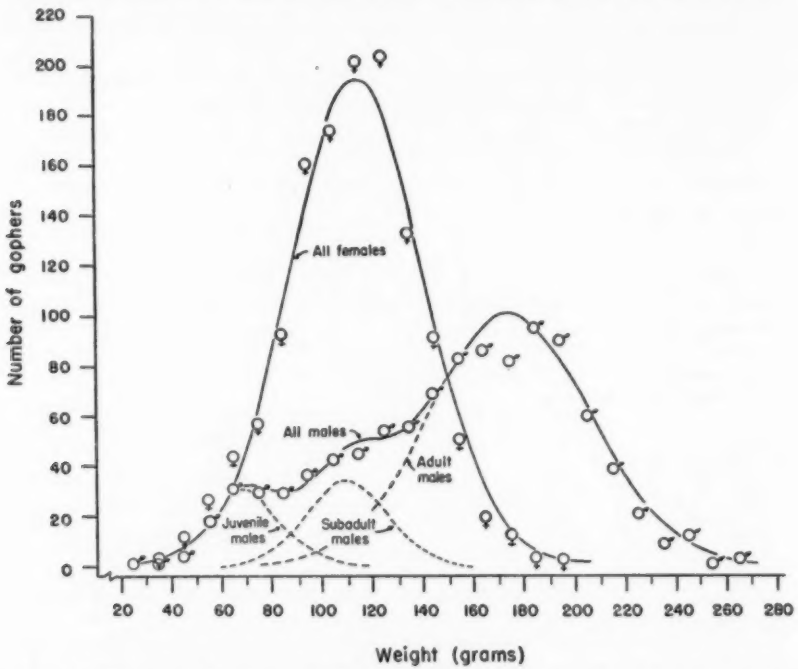

FIG. 1.—Frequency distribution of body weights of 1277 female and 986 male pocket gophers (*Thomomys bottae navus*) collected during 1932–1945 mainly from alfalfa fields in the vicinity of Davis, Yolo County, California. All female data points fitted by a single normal frequency curve. Male data points fitted (solid line) by combining three theoretical, overlapping, normal frequency distributions (dash lines) calculated for juvenile, subadult, and adult males.

the "mean female" weighs 112 grams, is 206.3 mm. in total length with a tail 58.2 mm. long and a hind foot length of 25.2 mm. For taxonomic purposes, modes may be more significant than means since they represent the most frequent type of individual on which taxonomic distinctions are generally based. The "modal male" in the Davis gopher population weighs 185 grams, is 235 mm. in total length with a tail 62 mm. long, and a hind foot length of 28 mm.; while the "modal female" weighs 125 grams, is 215 mm. in total length with a tail 57 mm. long, and a hind foot length of 25 mm.

Weights and lengths of females vary more or less symmetrically about the central values with only slight skewness to the right (mean weight = 112 grams, modal weight class = 120–129 grams; mean length = 206.3 mm., modal length class = 210–219 mm.). Male weights and lengths (total and head-body), on the other hand, show marked skewness to the right with a modal weight about 23 grams greater than the mean weight, and a modal length about 18 mm. greater than the mean length. To the left of the modal peak for male weights or lengths, there is a long, gradually ascending "plateau" overlapping female frequency curves for these characteristics. Males also show significantly greater variability in weight and length than females as indicated by their respective coefficients of variability (Table 2). Lengths of hind foot and tail are more or less normally distributed in both sexes (Fig. 2, A and B).

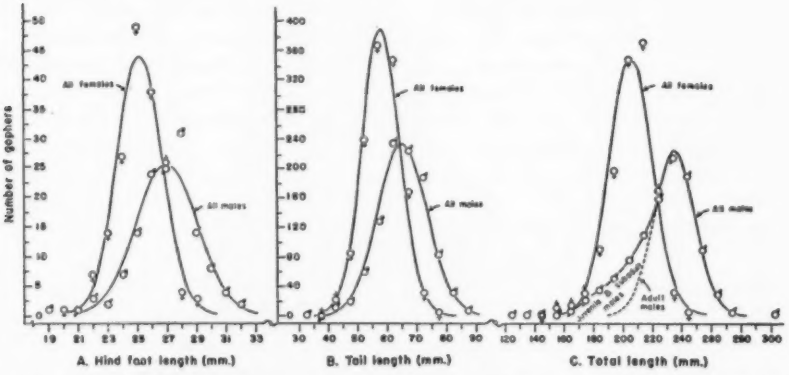

FIG. 2.—Frequency distributions of (A) hind foot, (B) tail, and (C) total lengths in *Thomomys bottae navus*. Data points fitted by single normal frequency curves, except those for total length in males which combine an assumed normal curve for adult male weights and an overlapping residue of juvenile and subadult males on the left. Compare with Figure 1.

The above-noted characteristics of the frequency distributions for male weights and lengths (total and head-body) can be explained on the assumption that they represent composites of possibly three overlapping normal "populations," namely juvenile, subadult, and adult males. The increasing activity with age of the male sex hormone is doubtlessly responsible for this heterogeneity as well as for the observed sexual dimorphism. Juvenile males and females are essentially of the same size and conformation, but as the animals mature, males gain in size over females and there is a noticeably greater development of their fore quarters.

The seemingly normal frequency distributions for female weights and lengths are likewise composite. The weight histogram (Fig. 3) consists of four widely overlapping but statistically distinguishable populations: (1) virgin females (with pubic symphysis present as distinguished from the following three categories in which the pelvic girdle is "open" *i.e.*, the pubic bones are widely sepa-

rated due to the permanent resorption of the symphysis at first pregnancy caused by an ovarian hormone, *relaxin*); (2) pregnant females; (3) recently-parous females (with placental scars and lactating mammae); and (4) parous females (adults with open girdle but no sign of recent breeding). Mean weights for these four categories are 87.8, 133.3, 125.5, and 120.3 grams, respectively (Table 2), each being significantly different from the others.

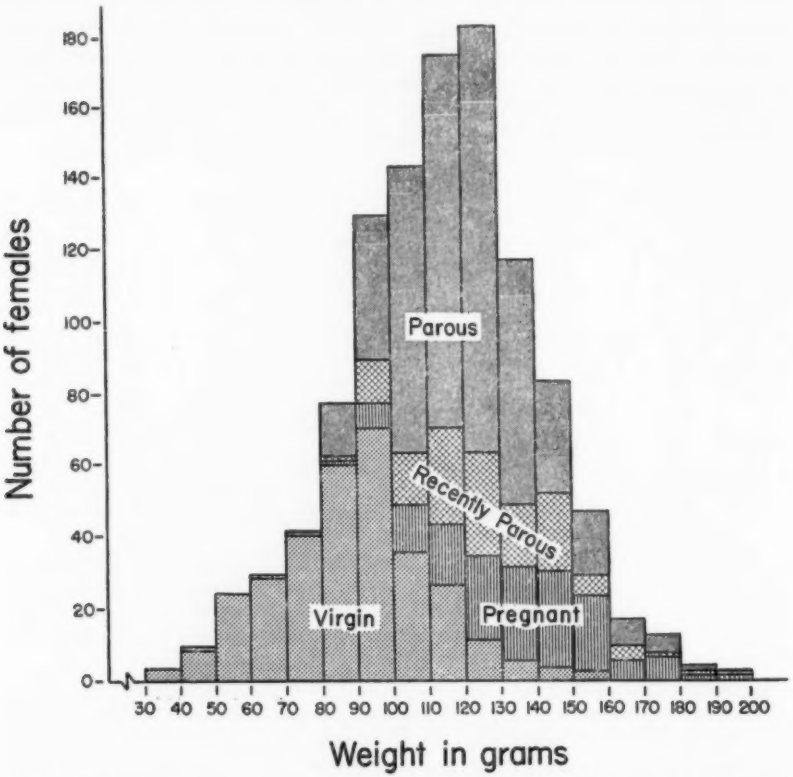

FIG. 3.—Frequency composition of a sample of 1094 classified females of *Thomomys bottae navus* with respect to weights. See text (page 447) for definitions of the various categories and Table 2 for their parameters.

Pregnant females, as expected, are heaviest, averaging about eight grams more than recently-parous females. Weights of embryos and associated structures account for most, if not all, of this difference, as 220 excised fetal sites (each including an embryo, its extraembryonic membranes, placenta, and surrounding uterine wall) averaged about 1¼ grams each with a mean of between five and six embryos per pregnant female. The five-gram difference between recently-

parous and parous females probably represents an additional normal increase in weight of female gophers during pregnancy which, with the extra 8 grams due to embryos, makes a 13-gram average difference between pregnant and ordinary adult females. Body lengths of the three classes of adult female are not significantly different from each other, however, so that on a length basis only two categories of females, virgin and adult, can be distinguished statistically.

The preponderance of large animals, especially males, as indicated by the right-handed skewness of weight and length frequency curves suggests selective factors operating in favor of the larger animals. Ensconced in their well-established burrows, with an easily available food supply which can safely be reached by tunneling through the soil, larger gophers have a distinct advantage over younger ones which must leave their home burrows and establish themselves in new locations. Predation losses during overland dispersal of young gophers is presumably severe, and may account for their relatively smaller numbers.

To determine the relationship between weight and length and between lengths of parts and body length, random samples of about 300 males and a like number of females were drawn for allometric analyses from the collection records. For analyses involving lengths of hind foot, however, data on all individuals measured for this character were used (137 males and 168 females). Head-body length, rather than weight or total length, was selected as the standard dimension or independent variable, because weights were found to be several times more variable than lengths, and because total length included tail length, one of the variables to be analyzed.

Logarithmic plotting of the paired variables resulted in linear alignments of data points thus conforming to Huxley's (1932) law of differential (allometric or heterogonic) growth.

$y = bx^k$, or $\log y = \log b + k \log x$, where
x = the independent variable or standard dimension
y = the dependent variable
b = a constant, the intercept of the regression line on the y—axis when x is unity, and
k = the differential growth constant, slope characteristic, or regression coefficient.

Results of the regression analyses are given in Table 3 and graphically represented in Figures 4–5. Weights in both sexes exhibit "postive heterogony" or "hypergonic growth" (k greater than one) with respect to head-body length. The relatively high values of k, 2.56 for males and 2.30 for females, are of the order expected since weight tends to increase as the cube of a linear dimension. The difference between k values for males and females results in progressive divergence of their weight-length curves and is expressed in the increasing disproportion between the sexes with growth. These considerations raise the suspicion that the greater sexual dimorphism reported for kinds living in deep soil and low altitudes may simply be due to the fact that they grow larger than those living in shallow soils and at high altitudes, rather than to inherent differences in differential

growth rate mechanisms between kinds. Allometric analyses on other species are strongly needed to settle this and related questions.

Lengths of hind foot and tail show "negative heterogony" or "hypogonic growth" (k less than one) with respect to head-body length, especially lengths of hind foot in females (k only 0.14), indicating relatively slow growth of these appendages during the period of life represented by the samples. High values of b for hind foot and tail length regressions, however, strongly indicate that these appendages must have developed quite rapidly and attained considerable "cap-

TABLE 3.—*Allometric growth parameters in Thomomys bottae navus and T. b. bottae (data from Sagal, 1942), using head-body length as the standard dimension (x)*

DEPENDENT VARIABLE, y	SEX	LIMITS OF x (IN MM.)	b	$b \pm$ S.E.$_b$
T. b. navus:				
Weight (in grams),	♂♂	104.5–234.5	0.0003	2.5624 ± 0.091
Weight (in grams),	♀♀	94.5–174.5	0.0011	2.3010 ± 0.096
Tail length (in mm.)	♂♂	104.5–234.5	4.207	0.5434 ± 0.030
Tail length (in mm.)	♀♀	94.5–174.5	3.798	0.5559 ± 0.003
Hind foot length (in mm.),	♂♂	104.5–194.5	2.070	0.5065 ± 0.042
Hind foot length (in mm.),	♀♀	104.5–184.5	12.215	0.1445 ± 0.057
T. b. bottae:				
Weight (in grams),	♂	36.0–111.0	0.0012	2.2714 ± 0.097
Weight (in grams),	♀	42.8–123.0	0.0015	2.2047 ± 0.061
Tail length (in mm.)	♂, I*	36.0–85.1	0.0129	1.7568 ± 0.042
Tail length (in mm.)	♂, II*	85.1–111.0	0.7756	0.8335 ± 0.077
Tail length (in mm.)	♀, I	42.8–80.0	0.0016	2.2418 ± 0.072
Tail length (in mm.)	♀, II	80.0–123.0	0.9863	0.8254 ± 0.050
Hind foot length (in mm.)	♂, I	36.0–85.1	0.0403	1.3835 ± 0.040
Hind foot length (in mm.)	♂, II	85.1–111.0	1.592	0.5544 ± 0.092
Hind foot length (in mm.)	♀, I	42.8–80.0	0.0063	1.8240 ± 0.126
Hind foot length (in mm.)	♂, II	80.0–123.0	1.451	0.5798 ± 0.166

* Roman numerals indicate successive periods, or "stanzas" of growth, each governed by a constant k value.

ital" before negative heterogony set in. Evidence supporting this deduction will be presented later.

That significant changes may occur in differential growth rates for most of the tabulated characteristics was suspected and confirmed by allometric analysis of Miss Sagal's (1942) data on early post-natal growth of a male and female of a related subspecies, *Thomomys bottae bottae*. Similarity of k values for weight-length regressions in these gophers (Table 3) shows that, for at least six to eight weeks after birth, males and females increase in weight at about the same differential rate with respect to body length. The k values obtained (2.27 and 2.20, for

male and female, respectively) do not differ significantly from each other nor from the k of 2.30 estimated for older females of *T. b. navus*, but the k value of 2.56 for older males of *T. b. navus* is significantly greater than these. Assuming equivalent postnatal growth rates in *T. b. bottae* and *T. b. navus*, it appears that male and female pocket gophers grow at about the same rate for the first month or two, after which the differential growth rate increases significantly in the male, but remains essentially constant in females. The postulated change in k for males is estimated to occur at an age of 45 days, or when they attain a head-body length

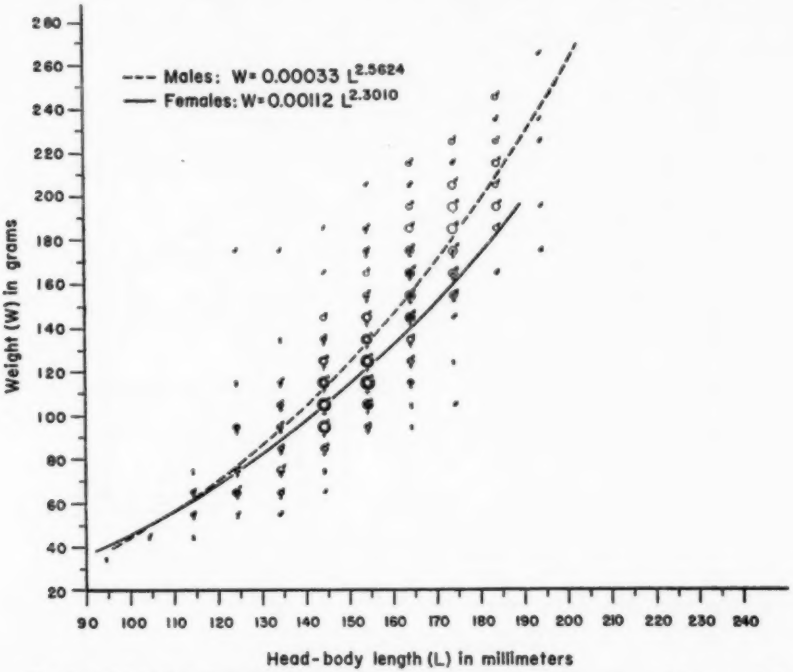

FIG. 4.—Weight-length regression in *Thomomys bottae navus*. The areas of data symbols are proportional to the numbers of gophers at each point.

of about 120 mm. and a weight of 63 grams (the point of intersection of weight-length regressions for males of the two subspecies). These increases may indicate the stage of life in the male gopher when the sex hormone (testosterone) starts to influence body size in males, and sexual dimorphism begins.

There is clear evidence of a shift from positive to negative heterogony in the differential growth rates of hind foot and tail (Fig. 5). For Miss Sagal's gophers, hypergonic k values of 1.38 and 1.82 for hind foot, and 1.76 and 2.24 for tail lengths in male and female, respectively, were calculated for the first 3 to 3½ weeks after birth. Then, abruptly, k values for these structures dropped to 0.55

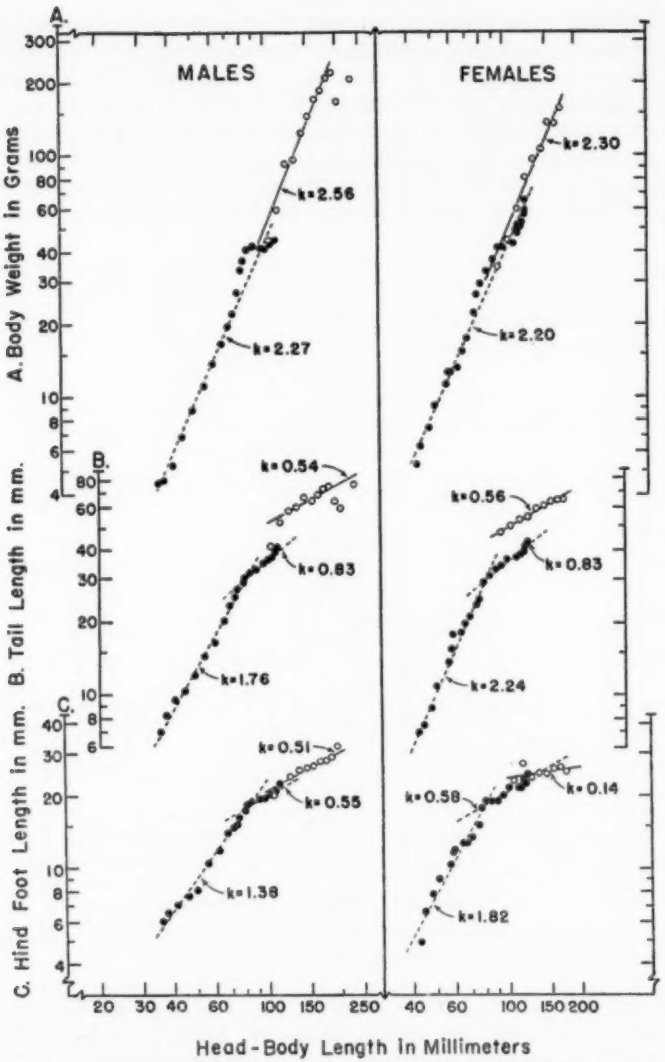

FIG. 5.—Allometric regressions of: A, body weights; B, tail length; and C, hind foot length on head-body length (all data plotted logarithmically) for males and females of two subspecies of *Thomomys bottae*, namely *T. b. navus* (open circles) and *T. b. bottae* (filled circles). Data for *T. b. bottae* are Sagal's (1942) measurements of two litter mates of opposite sex born and raised several weeks in captivity, while those for *T. b. navus* are averages of post-mortem measurements of samples of several hundred specimens from the Davis collection. Values of the slope constant, *k*, indicate differential growth rates of the various structures relative to head-body length.

and 0.58 for hind foot, and 0.83 and 0.82 for tail lengths in male and female, respectively. For both structures in both individuals, these sharp decreases in slope of the regression line, from hypergonic to hypogonic rates, occurred at a head-body length between 80 and 85 mm., a little less than the length of the smallest gophers in the Davis collection. It is noteworthy that the second set of k values for lengths of hind foot in *T. b. bottae* are nearly identical with those estimated for *T. b. navus*. For lengths of tail, however, the second phase k values in *T. b. bottae* are somewhat higher than those for Davis gophers, although both

TABLE 4.—*Length parameters for Thomomys bottae navus and neighboring subspecies in Central, Northern, and Coastal California*

SPECIES	NO. EXAMINED, SEX AND AGE	LENGTHS (IN MM.)			GENERAL DISTRIBUTION
		Total	Tail	Hind Foot	
T. b. navus Merriam	4♂♂ (ad.)**	203	67	27.5	Sacramento Valley, Calif.
	985♂♂ (juv.–ad.)*	227	65.3	27.1	
	4♀♀ (ad.)**	189	61	26.5	
	1277♀♀ (juv.–ad.)*	206	58.2	26.2	
T. b. bottae (Eydoux and Gervais)	5♂♂ (ad.)	267	81	33	Coastal region of California from Sonoma Co. to San Diego
	5♀♀ (?)	219	69	28	
T. b. leucodon Merriam	1♂ (young)	221	68	29	Northern California and Southwestern Oregon
	1♂ (old)	246	72	32	
	4♀♀ (?)	188	60	28	
T. b. pascalis Merriam	3♂♂ (ad.)	219	73	32	East side of San Joaquin Valley, California
	4♀♀ (?)	195	63	28	
T. b. mewa Merriam	1♂ (ad.)	225	60	27	Foothills east of San Joaquin Valley, California
	1♀ (ad.)	196	53	25	

* From Davis; ** from Redding.
(Above data from Bailey, 1915, except for specimens from Davis)

show negative heterogony. The shift from positive to negative heterogony is expressed in a change from relatively rapid initial growth of these appendages to slow growth during later life. The fact that the hind foot attains adult size rapidly, and has relatively low variability, makes it a useful taxonomic character.

It is now pertinent to compare size parameters of the population of *Thomomys bottae navus* from Davis with Bailey's (1915) measurements for this and neighboring subspecies of *T. bottae* (Table 4). Since Bailey's averages are based on small samples (usually four or five individuals) and no variance is given, precise statistical comparisons are obviously impossible and conclusions can only be tentative. Davis specimens of *T. b. navus* appear to be considerably longer on the

TABLE 5.—*Comparison of size parameters of Thomomys bottae navus taken from irrigated alfalfa fields with those from other fields, during corresponding months, in the vicinity of Davis, Yolo Co., California, 1944–1945*

HABITAT	MALES				FEMALES			
	Number Examined*	Mean Total Length ± S.E.	Mean Tail Length ± S.E.	Mean Hind Foot Length ± S.E.	Number Examined*	Mean Total Length ± S.E.	Mean Tail Length ± S.E.	Mean Hind Foot Length ± S.E.
		mm.	mm.	mm.		mm.	mm.	mm.
a. Alfalfa fields	304–109	225.9 ± 1.29	65.1 ± 0.45	27.1 ± 0.20	320–128	204.1 ± 0.88	57.4 ± 0.33	25.3 ± 0.14
b. Non-alfalfa fields	93–21	221.2 ± 2.13	63.1 ± 0.82	26.0 ± 0.37	140– 40	200.0 ± 1.14	56.9 ±	24.8 ± 0.21
Difference (a−b) ± $S.E._{a-b}$		4.7 ± 2.49	2.0 ± 0.94	1.1 ± 0.42		4.0 ± 1.42	0.5 ± 0.48	0.5 ± .25
$t = (a-b)/S.E._{a-b}$		1.9	2.1	2.6		2.8	1.1	2.0

* First number to left of dash indicates numbers used in calculating mean total length and tail length; number to right of dash indicates numbers used in calculating mean hind foot lengths.

average than topotypes from Redding, California (about 200 miles north of Davis, near the upper end of the Sacramento Valley). This difference is apparently due to greater head-body lengths in the Davis gophers since tail length averages in the two samples are roughly equivalent. If this difference between two samples of this subspecies from opposite ends of its geographic range can be substantiated, a south-to-north size gradient along the course of the Sacramento River may be indicated. Consistent with this cline theory is the fact that *T. b. navus* intergrades to the southwest with *T. b. bottae*, a larger but closely related subspecies, and to the north (as well as eastward and westward) with *T. b. leucodon*, another closely related but smaller subspecies whose northern representatives (topotypes) are more or less comparable in size to Redding specimens of *T. b. navus*. Topotypes of two other adjacent subspecies, *T. b. pascalis* and *T. b. mewa*, ranging to the south and southeast of *T. b. navus*, are about the same size or slightly smaller than Davis populations of *navus*. The larger size of gophers at the southern end of the range might be associated with deeper soils, lower altitude, or other ecological factors. It should again be emphasized that the foregoing theory is speculative, and that further size data, especially from intermediate points along the postulated gradient, are necessary to establish or disprove it.

The possibility of an association between size and local habitat conditions was investigated by computing and comparing sizes of gophers taken from irrigated alfalfa fields with those collected from other situations (orchards, grain fields, pastures, etc.). This analysis (Table 5) revealed that gophers from alfalfa fields are slightly longer on the average than those from non-alfalfa fields. The differences are small, but statistically significant for all length measurements except tail lengths in females (using $t > 2$ as a test of significance). Similar results are reported by Tryon (1947), who found highly significant weight differences both in adult males and females of *T. talpoides* taken from three mountain meadows which differed markedly from each other in soil composition and in the amount and type of vegetation. Gophers from the better meadows were larger. Size differences associated with environmental conditions may be due to better nutrition, or to older average age of gophers in the more favorable location, or both. The differences found between gophers taken from alfalfa fields and non-alfalfa fields at Davis, however, are clearly not large enough to account for the size discrepancy between the Davis population and topotypes of the same subspecies taken from the opposite ends of the Sacramento Valley. Genetic as well as environmental factors may be involved, and the relative influence of heredity and environment on size characteristics of pocket gophers remains to be determined. Full habitat data on collections will enhance their value for such studies.

SUMMARY

Biometric data on nearly 2300 specimens of the Sacramento Valley pocket gopher, *Thomomys bottae navus*, collected in the vicinity of Davis, Yolo County, California, were analyzed to establish size parameters for this population, to determine weight-length and other allometric relationships, and to compare sizes of this population with samples from other localities and with adjacent subspecies.

Gophers from Davis are characterized by marked sexual dimorphism in size of body and its parts. Frequency curves for weights, total length, and head-body length are skewed to the right, especially in males, but are fairly normal for other characteristics. Frequency distributions for weight, length, and other size characteristics are sometimes composites of several more or less widely overlapping but statistically distinct categories in the population such as juvenile, subadult, and adult males; or virgin, pregnant, recently-parous, and parous females. Heterogeneity in males is attributed to the ever-increasing influence of the male sex hormone with age. There is evidence of selective environmental factors operating in favor of larger animals, especially males.

Allometric growth constants based on head-body length as the standard dimension are given. Males and females gain in weight at about the same differential rate for about the first six weeks after birth, following which there is a significant increase in the differential growth rate in males. This increase is attributed to the male sex hormone and to progressive disproportion in size between the sexes. Hind foot and tail lengths increase relatively rapidly in both sexes during the first few weeks after birth, but then differential growth rates for these appendages decrease abruptly to relatively low values.

Specimens of *T. b. navus* from Davis, California, average larger than topotypes of this subspecies from Redding, near the northern end of the Sacramento Valley, and may represent the southern extreme of a south-to-north gradient traversing the range. *T. b. navus* intergrades in size with the larger *T. b. bottae* to the southwest and with the smaller *T. b. leucodon* to the north, east, and west. Gophers from irrigated alfalfa fields average larger than those taken from other situations, but the differences are too small to account for size differences between the Davis population, topotypes from farther north, and adjacent subspecies.

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THE OS GENITALE OF THE RED SQUIRREL, *TAMIASCIURUS*

By James N. Layne

The absence of the os penis in the red squirrel, *Tamiasciurus*, has been reported by Tullberg (1899), Pocock (1923), Mossman, Lawlah, and Bradley (1932) and Wade and Gilbert (1940). In the present study, however, a minute baculum and its homolog in the female, the os clitoridis, have been found in southern red squirrels, *Tamiasciurus hudsonicus loquax* Bangs, collected in central New York.

The bones were studied *in situ* from specimens prepared by removing the entire vulva or the penis distal to the crura and clearing in pure glycerin subsequent to brief maceration in a two per cent aqueous solution of sodium hydroxide. In several cases, the structures were stained with alizarin prior to clearing. Although the majority of the specimens were obtained from freshly killed animals, a few were removed from genital tracts preserved in 10 per cent formalin.

Description.—Male. The baculum was observed in each of 25 adults and subadults examined in which the glans penis had been carefully preserved. It is located within the glans at the extreme end of the filiform penis and can be observed macroscopically in the fresh as well as in the cleared penis. Its base caps the end of the corpora cavernosa at a point just above or slightly forward of the urethral orifice (Fig. 1, B). The total length of the bone varies from .17 to .34 mm., and the greatest depth from .08 to .15 mm. The mean length of 10 adult examples is .26 mm. while three subadult bacula average .20 mm.

The appearance of the bone in the cleared penis is rather granular and the shape somewhat variable (Fig. 1, C–F), though the usual tendency is to be conical. Usually the penis bone resembles in lateral aspect either an arrowhead, acorn, or lanceolate rod. The base of the os may be concave to receive the tip of the corpora cavernosa. It is generally oblique, with the proximal extension located on the dorsal side. There appears to be no significant difference in size or shape of the bone between adult and subadult animals, although in the latter it tends to be somewhat smaller and less expanded at the basal portion.

Female. The os clitoridis is irregular in occurrence, occurring in only four out of 13 specimens examined. When present, it is located approximately .2 mm. from the end of the glans clitoridis at the termination of the attenuated corpora cavernosa (Fig. 1, A). It is considerably smaller than the penis bone. The four specimens obtained were roughly spherical in form, and the diameter of the largest was approximately .08 mm. The presence of the bone does not seem to be indicative of age since of the four specimens in which it was observed, three were subadult animals. The os of the subadults is slightly smaller in diameter than the adult.

Discussion.—The presence of the baculum in the red squirrel has undoubtedly been overlooked because of its small size and terminal position within the glans where it may easily be lost. The suggestion by Wade and Gilbert (1940) that the tough, fibrous portion of the penis is the homolog of the os in other sciurids now appears to be incorrect. The statement that the penis of *Tamiasciurus* represents an unspecialized and primitive type (Wade and Gilbert, 1940) may also be

questioned since the diminutive baculum may be indicative of a more highly specialized type in which the os penis is undergoing regression.

Pocock (1923) elevated the subgenus *Tamiasciurus* to generic rank primarily on the supposed absence of the baculum and the symmetrical, filiform penis. This change has been adopted, with some reservation, in such later classifications as

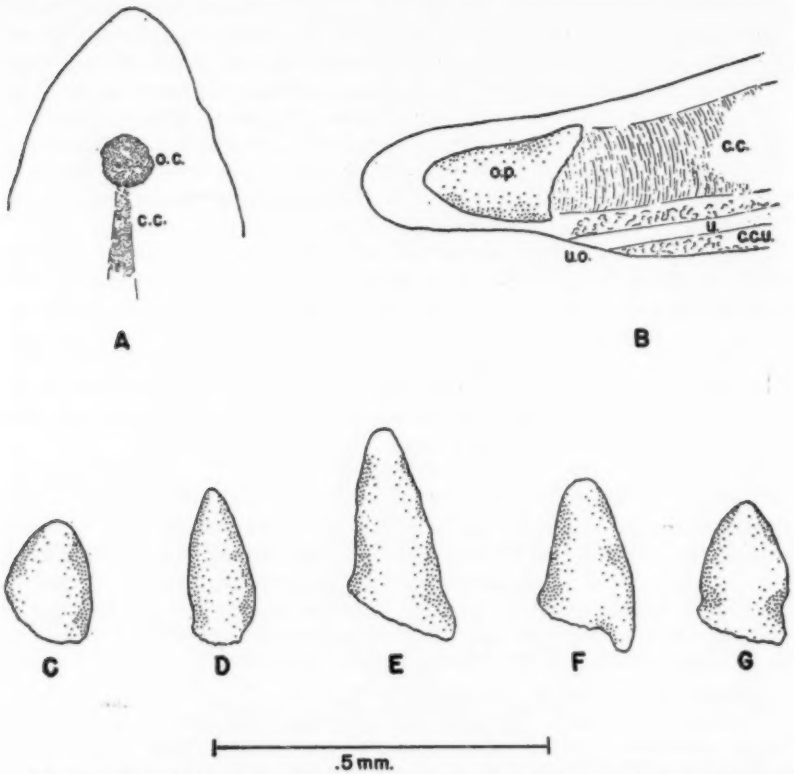

FIG. 1.—Os genitale of the red squirrel, *Tamiasciurus hudsonicus loquax*. (A) Distal portion of the glans clitoridis: o.c., os clitoridis; c.c., corpora cavernosa. (B) Lateral view of the distal end of the glans penis: o.p., os penis; c.c., corpora cavernosa; c.c.u., corpus cavernosum urethrae; u., urethra; u.o., urethral orifice. (C, D) Lateral aspect of bacula of subadults. (E–G) Lateral aspect of bacula of adults. (In C–G, ventral surface is to left.)

those of Howell (1938), Ellerman (1940), and Simpson (1945). Studies on the sciurid reproductive tract by Mossman, Lawlah, and Bradley (1932) and Mossman (1940) have revealed other unique features of the male and female genital organs of the red squirrel. Because of these fundamental differences and because of the fact that, although present, the baculum is vestigial, there would seem to be no basis for suggesting a change in the present systematic status of *Tamiasciurus*.

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OBSERVATIONS CONCERNING THE LIFE HISTORY AND ECOLOGY OF THE WOODRAT, *NEOTOMA FLORIDANA FLORIDANA* (Ord)

BY PAUL G. PEARSON

Published information concerning the life history and ecology of *Neotoma* of western United States is available in the works of Lay and Baker (1938), Vestal (1938), Horton and Wright (1944), and others. A major contribution to this subject from northeastern United States is that of Poole (1940). Information published on the life history and ecology of *Neotoma* from extreme southeastern United States is represented by incidental comments by Bangs (1898), notes by Chamberlain (1928) and Svihla (1933), and also by papers of Harper (1927) and Worth (1950). The following data were collected in a recent investigation in Gulf Hammock in Levy County, Florida.

The Gulf Hammock region is a relatively undisturbed tract of low, wet, hardwood forest that borders the Gulf of Mexico east of Cedar Key, Florida. Woodrats were trapped and their nests studied in the swamps and low hammocks as well as in the higher hammocks, but the greatest abundance was found in the ecotones between the high and low hammock communities.

Nests were found in barns, hollow logs, and subterranean chambers. The subterranean nests were in natural underground chambers under stumps and the bases of trees and root masses, and they were not excavated to any great extent. Most of the nests were located in dense tangles of low shrubs, and only very small piles of twigs and sticks, or midden heaps, were scattered around the nests. This is notably different from conditions in Okefinokee Swamp, for Harper (1927) described nests that varied in size from six feet in diameter and four feet

high to about two feet in diameter and one foot high. Also, Chamberlain (1928) reported nests two feet high and three feet in diameter near Charleston, South Carolina. In Gulf Hammock one nest, which had only a few sticks around the entrances, was located in a hollow oak log that measured 18 inches in diameter. A chamber, 48 inches long and ten inches in diameter, in this log had four entrances on one end and a single one at the other. A large mass of palmetto fiber, the size and shape of a volleyball, filled the chamber at one end, and inside this mass of fiber was a nest chamber which was four inches in diameter. Inside the main chamber in the log, debris was found which included: leaves and stem of blackberry (*Rubus* sp.) and blackhaw (*Viburnum corymbosum*), partially eaten water oak (*Quercus nigra*) and cow oak (*Quercus prinus*) acorns, hard parts of several Coleoptera, and a living slug (Gastropoda).

Data on the food preferences of woodrats were obtained when native food plants were placed in the cages of captive animals, in addition to a constant supply of corn and sunflower seeds. They refused, as food, parts of the following species of plants: *Juniperus silicicola*, *Yucca* sp., *Carya glabra*, *Liquidambar styraciflua*, *Zanthoxylum clava-herculis*, *Ilex glabra* and *I. vomitoria*, *Euonymus americanus*, *Acer floridanum* and *A. negundo*, *Callicarpa americana*, *Eupatorium* sp., *Pluchea foetida*, and *Pluchea longifolia*. They accepted, as food, parts of the following plants: *Paspalum* sp., *Panicum* sp., *Sabal minor*, *Myrica cerifera*, *Ulmus floridana*, *Prunus angustifolia*, *Cornus stricta*, *Vaccinium arboreum*, *Styrax grandifolia*, *Solanum gracile*, *S. carolinense*, and *S. floridanum*, *Hyptis mutabilis* and *H. radiata*, *Viburnum semitomentosum* and *V. corymbosum*, *Iva frutescens*, *Veronia* sp., *Elephantopus* sp., *Solidago* sp., *Baccharis halimifolia*, *Pluchea longifolia*, *Rudbeckia* sp., *Mesadenia* sp., and *Erechthities* sp. Nomenclature for trees is according to West and Arnold (1946) and for the remaining vegetation according to Small (1933). The woodrats ate parts of 81 per cent of the herbaceous plants, 57 per cent of the plants in the shrub layer, and only 37 per cent of the arboreal species offered them. They paid first and foremost attention to the young, tender portions of the leaves and stems offered them.

In Gulf Hammock, woodrats apparently breed throughout the year. Motile spermatozoa were found in the epididymides of specimens taken in January, February, April, May, August, and October. Litters were sired in January, February, June, August, and December, while copulation was observed in January and May. Therefore, active breeding condition was recorded for all months except March, July, September, and November. Harper (1927), in his work in the Okefinokee Swamp, reported active breeding condition in July, September, and November, while Svihla (1933) reported litters born in southern Louisiana during March.

Mating behavior of a single pair of woodrats was observed in the laboratory on January 11, 1951. Progeny of this pair, born January 5, 1951, were with the female at the time of copulation. Breeding desire was shown by the female when she removed the suckling young and moved in front of the male and assumed a position indicating her desire for copulation. After this action had been repeated twice, the male mounted and copulation appeared successful. Copulation

of this pair was again observed on May 1, 1951, although two 34-day-old young continued to suckle while the action took place.

The gestation period of one female possibly varied from 33 to 39 days. The copulation observed on January 11, 1951, possibly was responsible for a litter born 33 days later, although the male was not removed from the cage and fertilization could have occurred some time later. Likewise, the copulation observed on May 1, 1951, probably was responsible for a litter born 39 days later. This female, trapped June 19, 1949, gave birth to a litter on July 23, 1949, after isolation in the laboratory, thus showing the minimum gestation period for this litter was 34 days.

Seven litters born in the laboratory produced 21 young, of which ten were males and eleven were females. Each of two litters contained two and four young, while three litters contained three young each.

The newborn young have weak and unsteady movements. The skin, which has a chapped and scaly appearance, lacks noticeable pigment on the ventral side, but is darkly pigmented on the dorsal surface. Hair that measures one millimeter in length is present on the dorsal surfaces although it is scarcely noticeable on the ventral side. The tail is slightly bicolor and claws are present. Four incisors are present which enable the young to hold securely to the mammae. The eyes are closed although a fissure is present that marks the location of the upper and lower lids.

The young change rapidly during the first few weeks. By the eighth day the young are well furred on the dorsal and ventral sides. The eyes of the young open about the 17th day. Three young opened their eyes on the 17th day, while one each opened its eyes on the 16th and 18th days. Measurements and weights of young woodrats from five litters are given in Figure 1. In the figure, each dot represents the measurement of one individual, and the best-fit line was determined by the method of least squares.

Woodrats were easily trapped in a collapsible wire trap that measured 6 x 6 x 19 inches, manufactured by the National Live Trap Company. Fourteen woodrats were trapped, marked, and released by myself and Mr. W. L. Jennings, a co-worker in Gulf Hammock, in a study plot covering nine acres of mixed high and low hammock. Seven marked specimens were retaken. Three rats were retaken once, and one each was retaken three, four, six, and seven times for a total of 23 recaptures. The average distance between points of release and recapture was 178 feet, and the longest distance between points of release and recapture was 540 feet. If this can be used as an estimate of the size of the home range, it is somewhat larger than that reported by Lay and Baker (1938) as follows, "The average distance traversed between traps by these 8 rats was 108 feet . . . the shortest range recorded was 35 feet and the longest 285 feet." Vestal (1938) found that woodrats have a feeding range of at least 100 feet.

Apparently the Gulf Hammock woodrats are colonial, for they were abundant in localized situations and absent in other similar habitats. This colonial habit was also indicated when two females and one male entered the same nest after they were released on consecutive days. In the laboratory one female gave birth

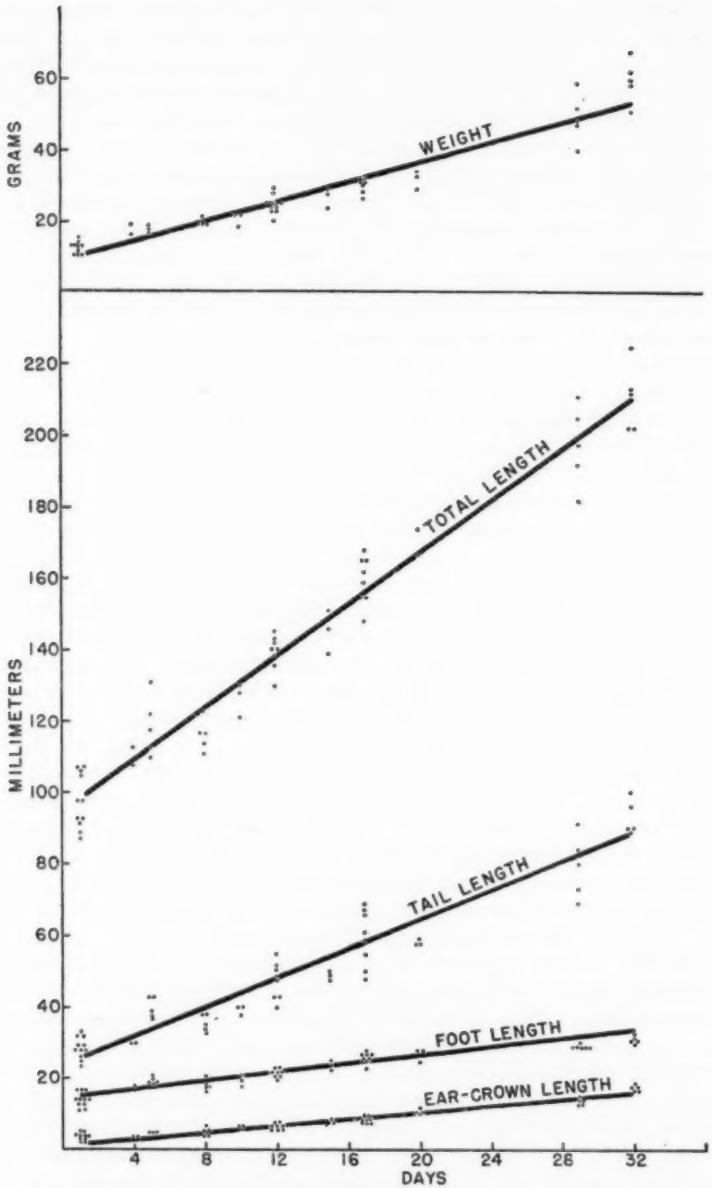

FIG. 1.—Measurements and weights of young woodrats from five litters.

to a litter of young on March 28, 1951, before she had weaned her litter of three 42-day-old young. Members of the newborn and 42-day-old young were nursed simultaneously, and the two adults and six young lived together in apparent harmony. When the newborn litter was replaced into the cage after measurement, a 42-day-old rat helped the adult female clean the smaller young. Shortly before a third litter was born on June 8, 1951, the adult female was still occasionally nursing her previous two litters, which at that time were 115 and 73 days old, respectively. Upon arrival of the third litter, the female refused to nurse the older two litters, yet the group of two adults and nine young lived in harmony.

The assistance of Dr. H. B. Sherman, who gave helpful aid and advice during the preparation of the manuscript, is gratefully acknowledged.

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THE OPOSSUM IN ARIZONA

By Raymond J. Hock

It is a well-known fact that the Virginia opossum, *Didelphis virginiana virginiana* Kerr, has been rapidly extending its range for some time. Anthony (1928) lists its distribution as follows: "Hudson Valley to northern Texas and almost to the Gulf Coast, west to the Great Lakes." Actually, 'possums had already been reported from outside this area, in Massachusetts and New Hampshire (Kennard, 1925). From that time on the species has apparently spread more quickly to the north and west, until now it is reported from Connecticut (Goodwin, 1935), western New York (Hamilton, 1933), Vermont (Osgood, 1938), and even Ontario (Smith, 1935). Seton (1929) has summarized other recent records.

The opossum, however, is still considered to be an eastern mammal, and despite introductions into California (Grinnell, 1915; Grinnell, Dixon, and Linsdale, 1937), and its natural presence in the eastern portions of New Mexico (Bailey, 1931), the 'possum has never been reported from Arizona. Bailey says, "slow and almost defenseless animals like opossums, which are usually fat and edible, are not well adapted to open desert country, as they depend mainly on cover for protection and for advantage in hunting their food." It is, therefore, not to be expected that 'possums would penetrate the Arizona desert country, both for the above reason and because there is such a wide gap between this region and their nearest known occurrence.

On December 18, 1949, an adult female opossum was brought to me alive by one of my students, William H. Woodin, III. It had been captured on the grounds of the Rincon Stock Farm, on Fort Lowell Road, on the outskirts of Tucson. The stock farm is a large irrigated, protected place, not far from the Santa Catalina foothills. This opossum was caged, and kept alive until June 7, 1950. It has been determined by Dr. David H. Johnson of the U. S. National Museum that it is *Didelphis virginiana virginiana*. The specimen is in the University of Arizona collections. About ten days later a young opossum, about 120 days old (Petrides, 1949), was killed in one of the buildings of the stock farm. It, unfortunately, was lost. The occurrence of this young animal shows that breeding is taking place in the area.

On May 2, 1950, an adult male was taken within the city limits of Tucson, about four miles from the stock farm. This 'possum was injured, and did not live long. It could not be preserved.

The introduction.—An attempt to explain these occurrences gives two alternatives: (1) the animals have arrived in the Tucson area by their own locomotion, remaining undetected all the way across New Mexico and that portion of Arizona supervening from the eastern boundary to Tucson; or (2) they have been introduced. It is conceivable that opossums could make an invasion across the two states, for there are many mountain ranges, often with permanent water, with no great expanses of desert between them. On the other hand, it is difficult to believe that they could make this extension of range undetected by any member

of the army of hunters that invades these mountain ranges each deer season, to say nothing of ranchers, trappers, and others whose business keeps them in the desert. However, knowledge of introductions of exotic animals in Arizona is a matter of common, although distressing, occurrence to the student of animal distribution there. It seems that there is a strong likelihood that the latter possibility is the one that accounts for the admission of the opossum to the faunal list for Arizona. I append the following extracts from a letter written to me by Mr. S. M. White, of Tempe, Arizona:

"I turned loose an old opossum and 13 young on Santa Cruz River at Jaynes Station, north of Tucson, in the summer of 1927. I know they raised, for I caught a young in 1928 near Jaynes Station. Dr. Vorhies, at the University of Arizona, kept it in the big cage for some time. . . . A Mr. Davis of Tucson told me his dogs have treed some on Santa Cruz River near Nogales. Also there are two negroes at Phoenix who claim their dogs have treed opossum near Nogales and Patagonia.

"The ones at Apache got out, 1 male and 2 females. [Note: Mr. White had 3 opossums in a roadside zoo at Apache Junction, Pinal County, in January, 1950.] The male was killed by Mr. Alvin Clary in the Queen Creek district. I have no way of knowing if the 2 females were bred before they escaped.

"Now I have an old one and ten young which I want to turn loose in northern Arizona and some near Hannigan Meadows. Of course, I'll have to find where the Game Department wants them."

A second letter from Mr. White says: "All of the opossums I have turned loose in Arizona came from Arkansas. . . . I'll turn loose the ones I have now on August 30th [1950] somewhere around Alpine or Hannigan Meadows." (These are in Apache and Greenlee counties, respectively.)

It would seem that the presence of this animal in the state of Arizona is explainable on some such basis as the above. It may seem doubtful that the 'possums liberated by Mr. White in 1928 would not show up for over 20 years, and that several would then be found. However, there may well have been other introductions of this animal into the general area, and it may be assumed that this exotic form has become established by means of introductions.

Opossums have been introduced into California (Grinnell, 1915; Grinnell, Dixon, and Linsdale, 1937), where they now occur widely (Austin, 1924; Bryant, 1927; von Bloeker, 1928; Koppel, 1915; Little, 1916; Tubbs, 1916); into Oregon (Jewett and Dobyns, 1929); into Washington (Scheffer, 1943); and into Minnesota (Mohr, 1931).

It is interesting to note that Jewett and Dobyns (1929) report that the occurrence of the Virginia opossum in Umatilla County, Oregon, was apparently the result of the liberation of three or four animals fifteen years before. In the six or seven years predating their paper fifty or more opossums were taken in a small area. There seems to be a clear parallel between this and the present case, if Mr. White's introductions are indeed the only source of origin of this mammal in Arizona.

Vorhies (1928) records the fact that an opossum from Arkansas had been given

him (this was an offspring of Mr. White's original release, as cited above), and that others have been released in the Tucson region. He says "... carried into

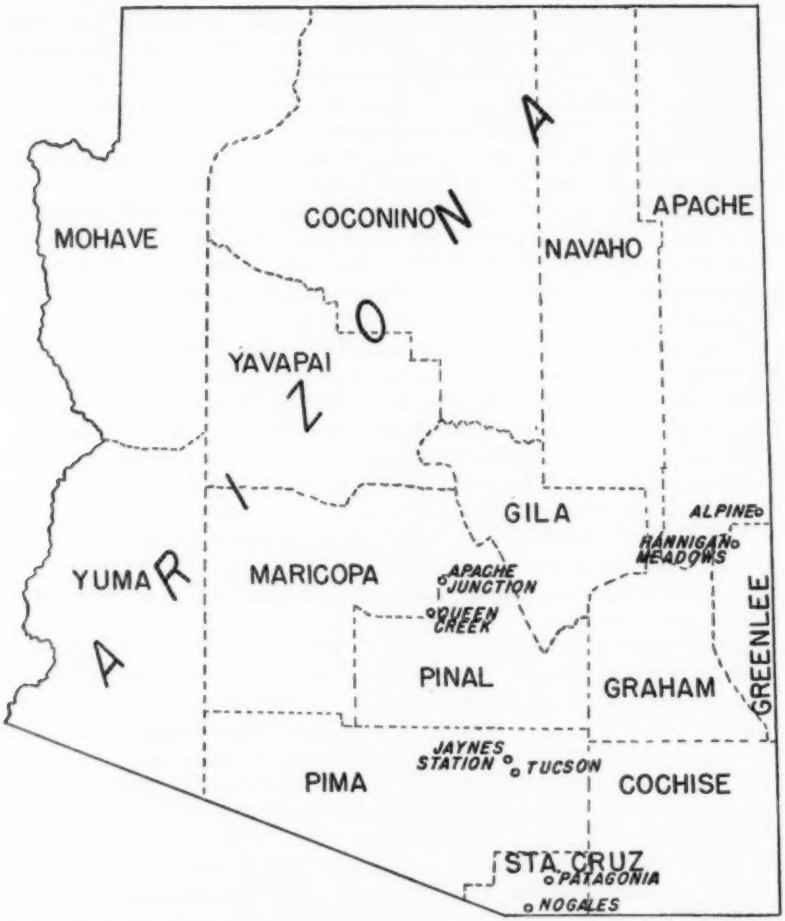

FIG. 1.—Known distribution of the opossum in Arizona. Localities mentioned in the text are shown as small circles. These localities are for specimens, sight records, and proposed introductions.

this new (and probably unfavorable) environment." In the latter respect it appears that he was not correct.

Bailey (1933) has reported the occurrence of *Didelphis mesamericana* subsp.? at Oputo, Bavispe River Valley, Sonora, Mexico. This place is only 80 miles south of the International Border, and 180 miles southeast of Tucson. It is con-

ceivable that this form might colonize semi-desert areas to the north, but the animals from the Tucson area are not of this species.

It should be unnecessary to expostulate against introductions of exotic animals into new regions, without adequate study of all factors. However, it should be noted that Mr. White mentions plans for further introductions in new areas, and also states that the Arizona Game and Fish Commission knows all about his actions, and apparently *approves of them.*

Implications of the introduction.—The opossum is one of the most heavily parasitized of American mammals, and many of its parasites are not known to occur in Arizona (in part, perhaps, due to lack of much study there). A partial list of its parasites includes: nematodes—*Cruzia tentaculata, Physaloptera turgida, P. ackerti, Gnathostomum didelphis, Viannaia viannai, V. bursobscura, Spirocerca longispiculata, Aspidodera harwoodi* (Chandler, 1932; Dikmans, 1931, 1943; Hill, 1939*a*, 1939*b*); trematodes—*Proalaria variabilis, Brachylaemus opisthotrias, B. virginiana, Rhopalias macrocanthus, Neodiplostomum lucidum, Eurytrema allentoshi, Echinostoma revolutum, Fibricola cratera, Diplostomum variabile, Paragonimus westermani, Amphimerus pseudofelineus* (Byrd, 1941; Byrd *et al.*, 1942*b*; Chandler, 1932; Denton, 1944; LaRue and Bosma, 1927; Leigh, 1940; Rausch and Tiner, 1949); cestodes—*Mesocestoides latus, Mesocestoides variabilis, Hymenolepis* sp., *Oochoristica* sp. (Byrd and Ward, 1943; Leigh, 1940; Rausch and Tiner, 1949).

Many of these parasites are listed by more than one of the above authors. In addition, the following authors have written on opossum parasites, although they list no additional species: Byrd *et al.*, 1942*a*; Dickerson, 1930; Mueller, 1930; Oldham, 1933; Reiber and Byrd, 1942. Further, Reynolds (1945) and Lay (1942) have recorded the presence of *Dermacentor variabilis* on the opossum. Cooley (1938) says that this species is one of two in this genus that carry the dreaded Rocky Mountain spotted fever. At the time of his writing, this tick had not been recorded from Arizona, although *D. andersoni*, the other carrier, is known from the northern part of the state. In addition to spotted fever, *D. variabilis* transmits tularemia, and has experimentally been shown to transmit bovine anaplasmosis. In a cattle state such as Arizona there could be serious consequences from the introduction of an animal that harbors the tick responsible for these diseases. It has also been stated that the 'possum carries tularemia (Mease, 1929) and endemic typhus fever (Brigham, 1936). It is obvious that the introduction of this mammal into a new area is fraught with possibilities of endangering the public health.

In addition to possible harm resulting to cattle, wildlife, and man by means of the introduction of new parasites and diseases, the poultry, fruit, and truck garden industries may be expected to suffer also. For the opossum is famed for its ability to make use of any food that comes its way. The new, but important, industries of these types around Tucson may be expected to feel the effects of its introduction.

It is a point of some importance to note that the opossum is a large-scale consumer of birds' eggs (Goodwin, 1935). The officials of the Arizona Game and

Fish Commission recently classed the roadrunner, *Geococcyx californianus*, as a predator of serious consequence to the Gambel's quail (*Lophortyx g. gambelii*) population in Arizona, and placed this interesting and unique bird on the all-year open list. This was despite the statement by Gorsuch (1934) that roadrunners are not of any great harm to quail. Now an animal that will almost undoubtedly bring the quail harm is being introduced into the state.

Perhaps the Californian sentiments will soon be felt in Arizona: "It is doubtful if we are to consider ourselves lucky in having acquired this addition to our mammal fauna. In fact, it is quite possible that we may live to greatly regret the circumstances which secured its introduction into our state" (Grinnell, 1915). A statement of several years later (Anon., 1927) showed that the above foreboding was justified: "The opossum is so prolific and he has such a wide distribution in California that it is now too late to exterminate this dangerous species and resort will have to be made to methods of control." Too late—only twelve years from the first report of its introduction!

Acknowledgments.—I am indebted to the following persons for help in the preparation of this paper: Mr. S. M. White, for freely giving of the facts at his disposal; Dr. David H. Johnson, U. S. National Museum, for making the indentification; Mr. Kramer A. Adams, California Division of Fish and Game, and Mr. Harold Severaid, Museum of Vertebrate Zoology, both for giving information on the introduction of the opossum in California; Dr. Robert Rausch, Arctic Health Research Center, for help in bringing the nomenclature of the parasites to date; Mr. Denny Constantine, Miss Susan Irving, and the librarians of the Arctic Health Research Center, all for furnishing bibliographic aid; Miss Mildred Wagner, for making the figure.

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SOME OBSERVATIONS ON COYOTE PREDATION IN YELLOWSTONE NATIONAL PARK

BY WELDON B. ROBINSON

From 1945 to 1950 the Denver Wildlife Research Laboratory conducted a study of coyote movements from and to Yellowstone National Park (Robinson and Cummings, 1951). During this period I spent some eleven months in and adjacent to the Park, and Biologists Maynard W. Cummings and Robert W. Sears, both formerly of the Laboratory, participated for approximately four months and two weeks, respectively. Duties included the capture, tagging, and release of coyotes (*Canis latrans*) and, in the later years, the collection of tagged animals. While in Yellowstone we were continually in the field searching for dens, attending traps, or hunting tagged coyotes. This work afforded excellent opportunities for studying coyotes in their natural habitats; the observations of their predation on big-game animals seem worthy of record.

In citing these incidents, there is no intention to imply that predation in a National Park with a critical range problem may be objectionable. On the contrary, the killing of big-game animals by predators under such conditions may serve a useful purpose in tending to hold the herds in check. This is especially true in National Parks where surplus game animals cannot be adequately harvested. Coyotes also were observed many times feeding on rodents, carrion, or other foods, but these frequently noted activities are, naturally, less spectacular than predation on big-game animals. The purpose of this paper is simply to bring out some of the hunting habits of coyotes, their capabilities, and some logical deductions.

Coyotes find unattended calves.—In the spring of 1946, coyotes frequently were observed inside the Park one to two miles northwest of Gardiner, Montana, and their actions indicated a den in the nearby foothills. On the morning of June 1, as I drove along a graded road in that vicinity, a coyote was sitting on a hillside about 150 yards away. On the chance that the animal might soon go to the den and thus disclose its location, I drove out of sight and returned with field glasses to a prominent point. The coyote remained motionless for several minutes, until

suddenly two other coyotes and a pronghorn (*Antilocapra americana*) came into view from the east. It was not clear whether the coyotes were chasing the pronghorn antelope or vice versa, but the three animals were closely bunched. As they ran in front of the first coyote they were joined by that animal, and immediately the three predators turned to the right and entered a patch of brush. There they struggled briefly with some object and soon started feeding. Finally, after rubbing their muzzles and throats on the grass, they departed in the direction where their den was later found. An inspection then revealed that the three coyotes had killed an elk calf (*Cervus canadensis nelsoni*). The calf's face and head bore several tooth marks, which no doubt were the fatal wounds. At no time was the mother of the calf in sight; she probably was spending the day in the more secluded foothills to the south. It was evident that the first coyote had located the hidden calf and kept it under observation until joined by the others.

During the spring of 1948, an airplane was used for a short time to aid in locating dens. On the morning of May 26, the pilot and observer sighted seven coyotes along lower Blacktail Deer Creek. Although a den was not observed, the concentration of coyotes suggested one in that vicinity. A short time later five of us started hunting on foot. Immediately we saw a cow elk fighting two coyotes, apparently protecting her calf. The animals were frightened and moved away. We hunted in that general vicinity for some time, continually sighting coyotes which for some reason were reluctant to leave. Perhaps an hour later we again approached the spot where the coyotes earlier were fighting the elk, and heard squealing in the brush. One coyote was hastening toward the sound, and a second coyote was frightened away before it had finished killing the calf; the coyote had been biting the calf's face and had pulverized the bones up to the eyes. No doubt the initial approach was responsible for the cow deserting the calf, but the coyotes were more persistent in their attack upon the calf than was the cow in defending it. Even though five men were scattered through that locality, probably never more than a mile from the calf and often much closer, the predators remained nearby to finally slip in and fatally wound the young elk.

Coyotes kill calf from band of elk.—On June 1, 1950, much of a prolonged struggle was witnessed in which coyotes killed a calf in the midst of a herd of elk. While walking along Crystal Creek, a companion and I observed several cows from a sizable herd, running from an open hillside into scattered timber. The disturbance continued for perhaps an hour. Finally, as we approached the center of commotion, a calf squealed, and the thunder of hoofs indicated that elk were running from that location. Continuing forward, we came over a slight ridge and, about 200 yards away, saw seven coyotes eating a calf elk with the mother desperately fighting them. The elk that had left the scene looked back nervously, and another band grazed into sight from the other direction, but neither group made any attempt to come to the aid of the beleaguered cow.

There was room around the calf for five coyotes with the other two awaiting their turn. One of the coyotes lay on a nearby ridge during some of the action, and the face of one of the others was covered with blood, presumably that of the calf. The cow would repeatedly lunge at the coyotes feeding on the calf and at-

tempt to strike them with her forefeet. At her approach they would scatter a few steps, and as the cow chased one, the others would close in behind and continue feeding. The coyote being chased would run a short distance, then circle sharply and return, to continue its meal when the cow again scattered the group. In this manner some coyotes were feeding on the calf almost continuously. The cow was helpless in stopping them; she simply ran herself to exhaustion in chasing first one and then another of the predators. At one time she stood panting while a coyote fed on the calf under her neck. As she weakened she chased the coyotes less frequently, finally permitting them to feed almost unmolested.

Olaus J. Murie (1951, pp. 152–153) describes an unusual incident reported to him by Almer P. Nelson, Manager of the National Elk Refuge in Wyoming, which may illustrate the extreme boldness of a pack of these predators. In this case a cow elk itself was attacked. Murie wrote: "When Mr. Nelson arrived on the scene, 11 coyotes were seen at some distance from the elk, which was then lying down. The coyotes had been feeding on the rump area of the living animal, and occasionally one would approach and tear at the flesh. Previously, workmen had seen this elk fighting off the coyotes, some tearing at the hind quarters, while others were being fought off in front. At Mr. Nelson's approach, she was barely able to get on her feet."

In Yellowstone it is not uncommon to see coyotes hunting in groups of two or more. Robinson and Cummings (1947) reported four and possibly five adult coyotes around one den, the extra ones being tagged pups of the previous year. Traps placed by the calf elk killed near Gardiner in the spring of 1946 captured a yearling male coyote, which was tagged and released. This animal was one of five adult coyotes sighted at a nearby den two days later. One of the seven coyotes that killed the calf on Crystal Creek had previously been tagged, and another was bobtailed. The tagged animal was collected that day, and found to be a female that had recently given birth to five pups; she had been tagged two years earlier at a den two miles away. A few days later, in using a "coyote-caller" near this old den-site, I attracted six coyotes in a group, one being the bobtailed animal. It is probable that this was the same pack, minus the tagged coyote, that killed the calf. When these family groups hunt together, as they frequently do, they appear entirely capable of killing an elk calf despite all its mother can do in its defense.

In collecting tagged coyotes in the Park, care was taken to avoid killing females with pups so small that they would starve. It was necessary to get returns during spring and summer; this work was carried on in April before whelping season, held at a minimum in May when pups were small, and continued in June when the young generally were old enough that, if left motherless, they would be cared for by the father. In this connection an observation of a captive male coyote caring for pups may be of interest. At Kim, Colorado, Lyle H. Autrey, a Fish and Wildlife Service hunter, took a male coyote pup from a den before its eyes were opened and kept it as a pet. When the animal was two years old, a small coyote pup was placed in the pen with it. The adult male promptly fed the pup by regurgitation, and continued doing so until the pup was old enough to chew meat by itself. After that the older coyote simply carried food to the younger one.

Later a young kit fox (*Vulpes velox*) was placed in the pen, and the captive male coyote fed the fox by regurgitation, but not the larger coyote pup. The young fox seemingly took advantage of the coyote's fatherly instinct. It naturally grew more slowly than had the coyote pup and was fed partially digested meat for a longer period. The actions of the adult male, which had been raised in captivity and had never roamed the wilds, suggest that the size of the young, probably more than its foraging ability, determines the period that it is fed by regurgitation.

Coyotes decoying elk.—The tendency of a cow elk to try to drive predators away may sometimes be the very act that causes her calf to be lost. Two incidents were witnessed in which it appeared that a coyote actually was inviting a chase by a mother elk. In the spring of 1948, Cummings watched a cow fighting a single coyote that apparently was trying to reach her calf hidden in a group of trees on the east slope of Mt. Everts. Finally, she chased the coyote out of sight over a ridge, and immediately three other coyotes appeared and started for the spot where the calf was hidden. The mother, joined by a second cow, returned in time, and the two elk escorted the calf out of the trees. Although the hunt was unsuccessful, there was the strong suggestion that the first coyote was decoying the cow so the others could go in for the kill.

While driving along the highway between Mammoth and Gardiner, Cummings and I momentarily sighted a coyote at the top of a bluff along the base of Mt. Everts. On the chance that the animal was at a den, we started up the slope to investigate, and met a cow elk chasing a coyote. Neither animal was exerting itself in the downhill chase. The coyote did not run as if its life were endangered, but merely fast enough to keep ahead of the elk; in turn, the elk appeared to move only fast enough to drive the coyote before it. The pace of both animals greatly increased when they suddenly sighted us and turned in flight. Although it was not known whether the cow had a calf in that vicinity, her actions suggested that she did. Where coyotes hunt in loose array in groups of two or more, as they so frequently do in Yellowstone, such a chase could mean the loss of the calf to others in the pack. It is evident that coyotes are not always successful in their attacks upon calves. The aggressive defense of the mother elk certainly is a deterring factor to predation, but does not always prevent it.

Coyotes feed extensively upon calves.—The remains of young big-game animals, particularly elk calves, were found at many of the dens located in tagging operations, but little effort was made to record such data. To cite only a few examples: in the spring of 1945, the remains of two elk calves were noted near a den on Mt. Everts; that same spring the fragments of one calf were found near a den on Stevens Creek; pronghorn antelope fawn and elk calf remains were found at a den in the Horseshoe in 1947; and the stomachs of two young, unidentified big-game animals were at a den in that locality a year later. In at least two instances it was known that the adult coyotes had eaten elk calves, yet remains were not observed at the dens. It is probable that any diligent search for such material, including an analysis of pup scats, would have disclosed that a large per cent of the pups that were tagged had been fed the young of big-game animals.

Adolph Murie likewise found much evidence of coyotes eating elk calves and

writes (1940 p. 48): "During the calving season the coyote feeds extensively on elk calves as is evident by the occurrence of remains in 290 droppings." He (Murie), however, found no field evidence of coyotes killing calves; reported several instances of calves dying from other causes and thus becoming available to coyotes as carrion; and concluded (p. 57): "During the calving period a few youngsters may be eliminated by the coyote but the data indicate that the calves eaten probably are largely carrion." Johnson (1951) likewise reported finding several calves that died from other causes, and noted one unsuccessful attempt at predation by the coyote, in or near Yellowstone Park. Since we were interested only in coyotes, and success in den-hunting or tag-recovery often depended upon observing these predators before or soon after they sighted us, it seems not unusual that we should see more of predation and less of the other causes of calf mortality. Because elk when alarmed warned coyotes through their incessant "barking," these game animals were avoided whenever possible. In doing so, we no doubt reduced the chances of finding uneaten calf carcasses. These casual observations, in which coyotes were sighted three times in the act of killing calves, and no uneaten carcasses of calves dying from other causes were seen, suggest that the method of approach may largely determine what is found. Our findings obviously were not representative of the various mortality factors, and perhaps the actual importance of coyote predation as a cause of calf losses lies between the extremes noted by us and by Murie (1940). Even so, it is apparent that the large Yellowstone elk herd, which is badly overgrazing its winter range, is not being adversely affected by coyotes. Elk reduction in Yellowstone is a problem, and the coyote, by killing calves, eliminates animals that otherwise may contribute to further decline of an inadequate range.

Predation victims quickly disappear.—Game animals that are killed by coyotes may be eaten or carried away and cached with amazing speed. The elk calf killed on Crystal Creek was about two-thirds eaten when the coyotes were dispersed by the tagged animal being collected. At that time five coyotes were still shoulder to shoulder around the calf, and all that remained was the front legs, neck, and head. These portions, too, likely would have disappeared within a short time. The only other remaining evidence that a calf had been killed there was blood on the grass. It was a mystery what had happened to the bones of the hind legs and portions of the back, as these were not located. Perhaps they were cached during an interval while we were out of sight approaching for an easy shot at the tagged coyote.

Animals killed in the winter likewise may disappear quickly. During January, 1949, traps often were visited several times nightly to permit the tagging and release of coyotes before the trapped foot froze. About 9 o'clock one evening, as I drove from Mammoth to Gardiner, the car lights illuminated a coyote attacking a young deer (*Odocoileus hemionus*) at the edge of the road. The deer lay quietly on its side with the coyote biting it around the head and neck. As the car approached, the coyote released the deer and ran; the deer then got to its feet and disappeared into the night. Since it was apparent that the deer's death had only been delayed, I returned two hours later to trap some coyotes for tagging at this

location, but by this time there was little of the deer left for bait. The remains lay about 15 feet from where the animal was last seen, and only scattered pieces of hide, a leg bone, and the stomach contents were left. These pieces doubtless would have been carried away before the night was over, had I not interfered.

A few nights earlier, while driving along this same road, E. R. Kalmbach, E. F. Grand, and I saw the remains of a deer that had been dead less than two hours. Tracks in the snow plainly told the story. Coyotes had chased the deer down a steep, frozen hillside to the edge of the road. The incline was so steep that a man had to cling to bushes to climb it; the coyotes came down on their feet, the deer came down rolling, and was eaten at the base of the slope. Little was left of the carcass when it was found, and the balance was carried away during the night. Before morning a light snow fell, and even though the remains lay in the borrow pit at the edge of the road, and the approximate location was known, I had difficulty in locating the spot during the next few days. When the snow disappeared, all that remained was scattered hair and stomach contents. A few days later a second deer was eaten overnight on the edge of the road at the base of this incline, and at that time I inquired at the Chief Ranger's office whether these animals had been reported in the count of big-game losses. The second deer had been, but the fragments of the first one remained undetected even though Rangers drove this road daily. This certainly is not meant as any reflection upon the vigilance of the Park Rangers, but the incident simply illustrates how readily the remains of predation victims may be overlooked.

Cahalane (1947) reported a similar disappearance of a deer carcass in Grand Canyon National Park. There he watched three coyotes kill a yearling deer one evening; by morning all that remained was a trail of scattered hair about 200 yards long. He wrote (p. 39): "Presumably the carcass was so reduced and torn to pieces as to make it possible for a predator to pick up and carry off the last remnant without permitting it to drag on the ground."

The fact that predation victims may disappear so quickly should be considered in appraising the various causes of big-game mortality. Animals that die of such causes as disease, malnutrition, and old age generally do so during the more critical periods of the year; then there may be so much carrion available to scavengers that the carcasses can be found by an observer before they are eaten. Should an animal die of such causes during other periods, even then there may be an interval of hours or days before the carcass is located by coyotes, and a further delay before it is taken by them because of their natural caution. In the winter carcasses that remain uneaten long enough to freeze simply cannot be devoured or carried away and cached as quickly as the freshly-killed animals. The longer a carcass remains intact, or partially so, the greater the chances of it being found by an observer, and the cause of mortality properly diagnosed. The body of a deer killed by coyotes, and reduced to little more than hair fragments overnight or in a matter of hours, has little chance of ever being tabulated. Unless an observer is fortunate enough to find the carcass before it is eaten, or to be there soon after and find track evidence, the cause of death—even if the fragments are located—too often cannot be determined. Animals that die of other

causes also may be completely eaten by coyotes, but not as quickly as the predation victims, and therefore are more likely to be found by an observer. It follows that predation should rightfully be suspected if animals seemingly disappear and leave no trace.

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NOTES ON MAMMALS FROM ALASKA

BY ROBERT L. STRECKER, FRED A. RYSER, WILLIAM J. TIETZ, AND PETER R. MORRISON

Although much attention has been focused on Alaska during recent years, distributional data on its mammalian fauna, particularly of the smaller species, are quite incomplete. These records are given to enlarge the knowledge of these distributions.

During July and August of 1950 more than 200 specimens of small mammals representing some 15 species were live trapped for a study of temperature regulation at the Arctic Aeromedical Laboratory, Fairbanks, and the University of Wisconsin. These studies were supported in part under contract with the Air Materiel Command and research grant from the Wisconsin Alumni Research Foundation. We are indebted to C. O. Handley, Jr., and Dr. D. H. Johnson of the U. S. National Museum for identification of the shrews, lemmings, and mice. Specimen numbers refer to the University of Wisconsin Zoological Museum.

Trapping was largely with "Sherman-type" live traps (2- and 3-inch) and collapsible wire traps (8–12-inch), but occasionally with steel traps (#00–2). An average "man-day" in the field represented the setting of about two dozen Sherman and two to four wire traps with visits made at three- to six-hour intervals. Collecting operations totaled 131 man-days in the field and were largely in central Alaska along the highway system, but included outlying locations as shown in Fig. 1.

ACCOUNTS OF SPECIES

Sorex cinereus hollisteri (UWZ 13981–6).—About a dozen of these shrews were trapped. Specimens were obtained at Swede Lake, at several areas at and east of Ladd, and at Steel

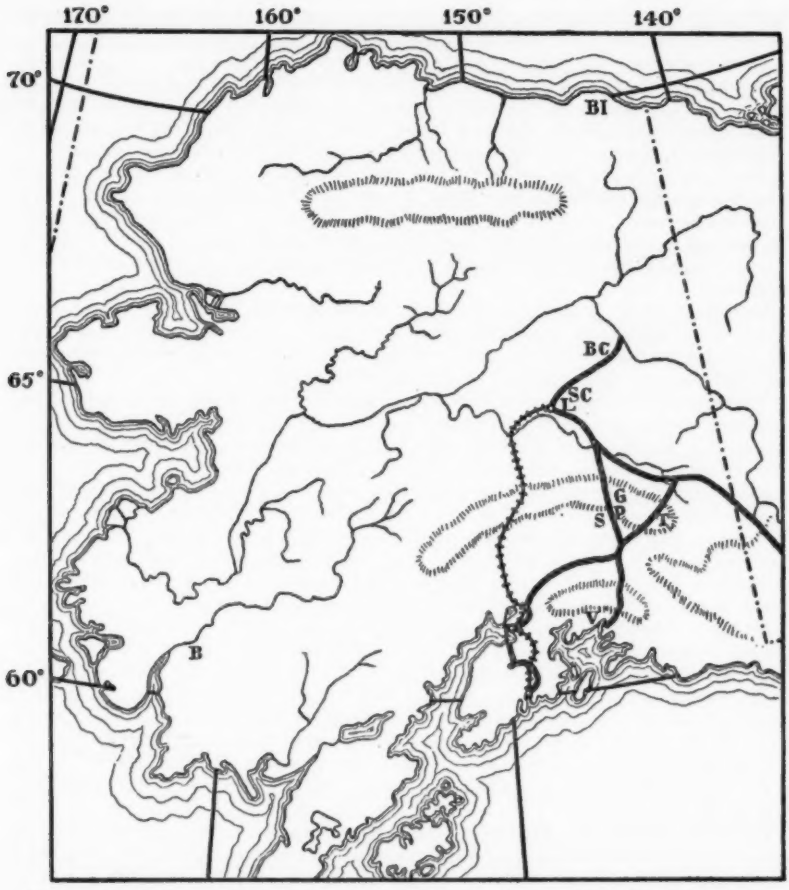

FIG. 1.—Outline map of Alaska showing collecting locations: (L), Ladd Air Force Base, small wooded areas adjacent to the Chena River (11 man-days), and east of Ladd, an extensive undisturbed area lying over the crash lane across the Chena River (12 m-d); (SC), Steel Creek, a similar larger area lying 15 miles northeast of Ladd (12 m-d); (BC), Birch Creek, near Circle Hot Springs adjacent to the Steese Highway (10 m-d); (BI), Barter Island, open tundra on Barter Island and the adjacent mainland (12 m-d); (P), Paxon Lake, adjacent to the Richardson Highway (4 m-d); (S), Swede Lake, high wet area 15 miles southeast of Paxon Lake (12 m-d); (G), Gakona Glacier, high, steep, open slopes near Gakona Glacier and Summit Lake in the Alaska Range (22 m-d); (T), Little Tok River, along Tok Cutoff (8 m-d); (V), Valdez, on tidal flats and heavily-covered adjacent areas (8 m-d); (B) Bethel, along the Kuskokwim River in the tidal region near its mouth (15 m-d).

Creek. They were found in mossy damp spruce woods, in low boggy areas, and in dry upland deciduous woods. Most were caught in early evening or early morning. In one case their

distribution was quite localized, five adults being trapped in a single 10 x 20-foot area of a spruce woods at Ladd while none were taken elsewhere in the woods.

Sorex obscurus.—One specimen was trapped at Swede Lake.

Sorex sp.—Two extremely large shrews (estimated weight, 10 grams) were trapped in a marsh bordering the harbor at Valdez. Careful examination indicated that they were not *Sorex palustris* since the characteristic fringe of hair along the hind foot was not visible. Unfortunately, the specimens were lost before complete identification could be made.

Myotis sp.—During the latter part of July bats were observed on two consecutive evenings. A single bat was seen flying at Ladd. The following evening a bat was again seen hawking insects over a little creek east of Ladd. Attempts at collection were unsuccessful, and bats were never seen again during the remainder of the summer. Although we have found no record of bats in central Alaska their presence was not considered unusual by local residents.

Mustela erminea.—A short-tailed weasel was trapped near the Gakona Glacier area in a steel trap concealed under a pika haypile on a rocky outcrop. Another weasel was shot near Bethel along the bank of the Kuskokwim River where weasel signs were often seen among the driftwood piled along the bank. A third weasel was seen along the Little Tok River.

Vulpes fulva.—During the first week of July a red fox pup (weight on July 21, 1.6 kg.) was captured by hand along the Richardson Highway south of Big Delta. Three individuals were seen in the field—two of the red phase at Gakona Glacier and one cross fox near the Delta River. An occupied burrow was found along the Delta River.

Alopex lagopus.—Two arctic foxes were flushed from their burrows on Barter Island and another from a burrow on the adjacent mainland. The dens were in open tundra, but in a local region which was slightly elevated (4–5 feet) over the surrounding area. One was excavated to disclose a nest chamber about three feet under the surface, with two entrances. In addition, there were six to eight other holes in an area about 20 feet square which were interconnected to form a shallow tunnel system immediately under the surface.

Marmota caligata caligata (UWZ 14017).—Hoary marmots were common at Gakona Glacier. One specimen was shot and four were trapped. They were found on the rocky upland slopes and alpine meadows and frequented the same talus slides as the pikas, using holes leading back under the slide. Their burrows were also found in alpine meadows as far as 200 yards from the edge of the talus slide with well-worn runways showing where they moved back and forth from the talus slide to their meadow burrows. In late August they were carrying grass into their burrows. The weights of three young of the year captured the last week of August were 1.42, 1.17, and 1.39 kg., respectively. The specimen shot carried abundant fat stores.

Citellus parryi plesius (UWZ 13975).—Arctic ground squirrels were common in the open country along the Richardson Highway between Big Delta and Paxson, and were easily live-trapped. Often several individuals could be seen along the road at one time. At Gakona Glacier 13 ground squirrels were in sight at one time on a small knoll. North of Fairbanks along the Steese Highway the *Citellus* were much darker in color than those from the Paxson area. *Citellus* were also very abundant in the Chugach Mountains around Thompson Pass at an elevation of about 2000 feet.

Tamiasciurus hudsonicus.—Red squirrels were collected at various stations: east of Ladd, at Steel Creek, at Birch Creek, at Swede Lake, at the Little Tok River, and at various points between Paxson and Valdez. They were abundant around dump areas, and they used burrows in the ground. At Steel Creek one pile of spruce cone scales around a burrow in a spruce-birch woods was about two feet deep and three feet in diameter. East of Ladd, red squirrels were found living in an area covered by small birch trees with a few scattered spruce all less than seven feet in height. This area was more than 200 yards from any sizable trees. Since no tree nests were found anywhere it would appear that the squirrels live in burrows during the entire year. A group of squirrels in captivity were given hickory nuts, which they ignored completely until a few were cracked open. Subsequently they opened them quite readily.

Castor canadensis.—One specimen was collected in a slough east of Ladd. Beaver were often seen in streams over the whole central Alaskan area.

Clethrionomys rutilus dawsoni.—The red-backed vole was by far the most abundant mammal in Central Alaska. They were obtained at all trapping stations, except Barter Island and areas above timberline. In central Alaska, they were captured in spruce woods, both in low wet areas and drier uplands, and in birch woods. In these wooded areas they were either common or abundant, often showing a trapping return of 30 per cent per day. In the vicinity of Bethel these voles were present, but not abundant; 150 trap-days yielded only one mouse though several were seen running among the tangle of driftwood along the banks of the Kuskokwim River.

A number of pregnant females were captured during July. Six litters ranging in size from five to eight young were born in captivity. The young survived well in captivity despite frequent handling.

Microtus miurus oreas (UWZ 13989,-92,-93).—These voles were extremely abundant on the shrubby slopes and alpine meadows at Gakona Glacier. Their faint bird-like alarm notes could be heard all about, and they were often seen, but very difficult to live-trap. Since they made extensive interconnecting tunnel systems they could not be dug out. One individual of this species was collected at Swede Lake.

Microtus oeconomus macfarlani (UWZ 13979,-87,-88,-90).—These voles were collected at Birch Creek, Ladd, Circle Hot Springs, and Paxson Lake. They were occasionally found in buildings in settled areas.

Lemmus trimucronatus alascensis (UWZ 13993–4).—Two brown lemmings were captured at Barter Island.

Dicrostonyx rubricatus rubricatus (UWZ 13978,-80,-91).—Three collared lemmings were taken at Barter Island, one of which was a female with four young. Live-trapping was not successful; the animals were obtained by digging up a large number of burrows or by catching them above the ground.

Zapus hudsonius.—A report was received of the presence of jumping mice in the area along the east bank of the Delta River near its junction with the Tanana River. A native of this region gave an unsolicited, accurate description of a jumping mouse, stating that during several summers prior to 1950 these animals had been fairly common. One night's trapping with four dozen Sherman traps gave no returns.

Ondatra zibethica spatulata (UWZ 13974,-76).—Three muskrats were obtained at Ladd. A pregnant female carrying seven embryos, averaging 7.5 mm. crown to rump, was collected on July 30. One specimen, taken during the first week of September, had wandered out on a runway and been accidentally killed.

Erethizon dorsatum.—An immature porcupine was captured at Birch Creek. At Ladd they were reported to be common on Birch Hill, a restricted area.

Ochotona collaris (UWZ 13977).—Pikas were found in broken limestone outcrops at Gakona Glacier at an altitude of about 4000 feet. In late August they were busily cutting and storing herbs in the broken talus area. Their calls could be heard all day and even during the short night. Five pikas were trapped from one slide area, three being caught at one haypile and two at another. A third pika was observed at the latter pile after the trapping was concluded. A single haypile often contained up to two-thirds of a bushel of drying herbs. No pika signs were found in the pellets at a hawk's nest located on a ledge directly above the talus slide, though several weathered pika skulls were found among the rocks on the slide. Live traps were used without success and the pikas were finally trapped by placing No. 0 steel traps under the edge of the haypile. Although the leg might be severely injured by the trap, the pikas would eat grass and herbs a few minutes after being caged.

Lepus americanus.—Four snowshoe hares were captured at Birch Creek. One was seen at Steel Creek and one east of Ladd. At no place, except Birch Creek, were fresh runway signs or fresh droppings at all frequent although the hares were considered "very common" in the vicinity of Fairbanks.

Large game.—No effort was made to find large game mammals, but some were observed

incidentally while in the field. Moose (*Alces*) were seen near Paxson Lake and around Fairbanks. Caribou (*Rangifer*) were seen near Gakona Glacier and on the mainland adjacent to Barter Island. Bison (*Bison*) were seen several times in the bottoms of the Delta River. One herd contained about 30 head, including several calves. A mountain goat (*Oreamnos*) was seen in the Chugach Mountains near Thompson Pass. Tracks and fresh scats of grizzly bears (*Ursus*) were found near Gakona Glacier.

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GENERAL NOTES

TWO NEW RECORDS OF THE SPOTTED BAT IN CALIFORNIA

What appears to be the tenth record for the spotted bat, *Euderma maculata* (Jour. Mamm., 31: 197, 1950), was brought alive into the Yosemite Museum on August 15, 1951. The specimen, a male, lived for about 18 hours after this. Measurements, recorded in millimeters, are: length, 112; tail, 46; hindfoot, 7; ear (notch), 39; tragus, 16; forearm, 48. A study skin, Yosemite Museum No. 944, was prepared and the carcass preserved in alcohol. These are now on deposit at the Museum of Vertebrate Zoology, University of California, Berkeley. So far as literature available to the author reveals, Yosemite Valley is the first locality to yield two specimens, one having also been taken there August 17, 1931 (Jour. Mamm., 13: 162–163, 1932). It may prove significant that capture was almost on the same day of the month in each instance.

A spotted bat, presumably this specimen, was found alive August 13, 1951, by Stephen Unger, age 9½ years, son of a park visitor. He seems to be a reliable, intelligent boy, and he supplied these facts: It was on the bank of the Merced River in Campground No. 15, about one foot from the water's edge. A "yellowjacket" had bitten the bat on each wing (humeral area?) and was endeavoring to "sting" it on the body. The bat tried to fight off the insect with a hind foot. Apparently, the damp and bedraggled bat could not take off. At first glance, as it crawled over the surface of the ground, the boy thought it was a tarantula. He and his young companions rescued the animal from the yellowjacket(s) and took it to the family campsite. They placed it under the overhanging roots of a pine tree.

After an expression of interest on the part of Ranger-Naturalist Sam Elkins, Stephen went back, two days later, to the vicinity and found the specimen that he brought into the Yosemite Museum. It was about three feet away from the place where he had put the August 13 bat, clinging to the bark of another tree only a few inches above the ground. This animal had definite injuries on the humeral area of each wing which certainly resembled the marks left by the bite of a yellowjacket (Pl. I, upper).

At the museum, the animal was placed in a small cage where it clung upside down on the screen sidewall in the fashion common to so many bats. Whenever disturbed, especially when off balance as it was being examined, the bat curled its ears, partially folding them lengthwise, down alongside the neck until the tips were recurved. The effect bore a startling resemblance to the horns of a mountain sheep, this appearance being heightened by the erect tragus taking the place of the ear of that form. In fact, laymen, viewing this, assumed that it was some sort of horned beast. None of our photographs show this behavior at its extreme.

Plate I (lower left) shows the normal carriage of the ears, erect, directed somewhat forward, with the tips slightly recurved. It also shows how crawling was accomplished by using the hind feet and the wrists, the wing folded and arched. The animal definitely "walked" with the wrists, and could travel on a horizontal plane with considerable facility.

Rather extensive photographic operations involved considerable handling of the live

animal, during which it emitted soft, extremely high-pitched, metallic squeaks. It made no strong defense against handling, such as biting, and, as the work progressed, one of the photographers, Mrs. Mary V. Hood, was able to pick up the animal with impunity and carry it about resting on her hand. The thread which was secured to the hind leg of the bat was loosely held at the same time. It survived the photography under the summer sun in apparently good condition, and after it was returned to the cage it made the second of two feedings, on cottage cheese, during the period it was at the museum. So far as could be observed, it did not interest itself in live insects which were released in the cage. On the morning of August 16 it was found dead on the floor of the cage.

PLATE I

Spotted bat, Yosemite National Park, August 15, 1951

Seasonal Ranger Robert Hiller, Yosemite National Park, upon seeing the live spotted bat, mentioned to the writer that he had once seen a similar bat while on a mineral collecting trip in the Barstow, California, area.

On March 22(?), 1948, the party of which Mr. Hiller was a member stopped at Granite Wells (near Pilot Knob), San Bernardino County, to replenish their water supply. The water issued from a cave dug into the side of a hill, the entrance of which was protected by a wooden door. Hanging from a rock projection within, they "noted a small bat with very large ears and three white markings on the dark dorsum of the body." He states further, "Although notes were taken at the time, this specimen was not taken for two reasons: 1) I was not familiar with the genera of bats at that time; therefore, no immediate identifica-

tion was possible; 2) the trip was primarily a mineral hunt and no collecting or preserving equipment was carried." He had been previously discouraged from publishing the incident because he did not collect the specimen. Because identification is so unmistakably easy for this form, the writer believes that the incident should be recorded, and does so with Mr. Hiller's permission.

I gratefully acknowledge the photographic assistance given by Ralph H. Anderson, Administrative Assistant, and Mrs. Mary V. Hood, National Park Service Collaborator.—HARRY C. PARKER, *National Park Service, Crater Lake National Park, Oregon.* *Received January 4, 1952.*

BEAVER TRAPPED BY TREE

The American beaver (*Castor canadensis*), in spite of its seemingly hazardous method of obtaining food by the felling of trees, appears to be remarkably free from accidents while engaged in this operation. The literature on the beaver contains but few specific references to these animals being killed by trees that they have cut.

On October 27, 1951, on one of the larger islands in the Wisconsin River near the Dane County-Iowa County boundary line, we found a large beaver that had been trapped by a cottonwood tree (*Populus deltoides*) which had dropped on its right hind foot. The animal was still alive, but apparently had been trapped for at least 36 hours or more, judging from the compacting of the ground beneath it and from the excrement present.

As nearly as we could reconstruct the near tragedy, the following appears to have occurred. The beaver, a mature adult, estimated weight 45 to 50 pounds, started to fell a 12-inch-diameter cottonwood tree standing about six feet from the bank of the river. The cottonwood as it was severed from its stump lodged against a small elm tree (*Ulmus americana*) and was thus prevented from falling. The beaver apparently continued cutting until the trunk was completely severed from the stump. The entire cut surface of the stump shows tooth marks indicating that the tree had been completely separated from the stump before dropping. We surmised that at this point the cottonwood was suspended above the ground due to the entangling of its top with that of the adjacent elm. The beaver then attempted to dislodge the cottonwood from the elm. However, instead of falling horizontally, the cottonwood merely slid over about 10 inches from its stump and dropped in a vertical position upon the right hind foot of the animal. The entire hind paw and about one inch of the hind leg above the heel were pinned beneath the butt of the trunk in such a way that the animal was allowed very little freedom of movement. It had made one or two futile attempts to gnaw at the trunk which had pinned it, but other than this there was very little evidence of struggle.

The animal was in good flesh and quite docile when we found it. After our freeing it by digging out the earth from beneath the trapped paw, the beaver made no attempt to escape so we placed it upon the edge of the low bank bordering the river, whereupon it slid to the edge of the water, drank avidly, and then dived and swam upstream. Later, it came back downstream, and when last seen was swimming across the river to another island.

The animal was so securely held that it seems certain that it would have perished had it not been found by us. The paw by which it was held was badly bruised and flattened and it is quite possible that the animal will lose part or all of this member. However, there are accounts in the literature of these animals losing one or more feet in steel traps and surviving with no apparent ill effects.

The beavers found along this stretch of the Wisconsin River are entirely bank dwellers and, due to a scarcity of aspen in this region, are forced to cut large specimens of cottonwood (*P. deltoides*), ash (*Fraxinus* sp.), box elder (*Acer negundo*), willow (*Salix* sp.), and some willow brush, largely *Salix longifolia*, for winter food. It is of interest to note that on these heavily wooded islands a very high percentage, probably approaching 25 per cent, of all the large trees cut by beavers are hung up so that they are unavailable to the animals.

We have hunted in this area over a period of the last five years and, while beaver sign

has always been evident, the animals seem to be much more abundant this year than in previous years.

The photograph taken by Hugh Wilmar (Pl. I) shows the beaver held by the tree trunk exactly as it was found by us.—ROBERT S. ELLARSON AND JOSEPH J. HICKEY, *Dept. of Wildlife Management, University of Wisconsin, Madison 6, Wis.* *Received December 14, 1951.*

PLATE I

Beaver trapped by cottonwood tree that it had cut and which had dropped on its right hind foot. The felled tree leans against a small elm which cannot be seen in the photograph. The bare earth in the foreground shows the radius of the animal's movement. Photograph by Hugh Wilmar, Dept. of Wildlife Management, Univ. of Wisconsin, October 27, 1951.

FUR SEAL BLUBBER

A sample of frozen seal blubber from the fur seal, *Callorhinus ursinus*, was obtained from Dr. V. B. Scheffer of the Fish and Wild Life Service, Seattle, Washington. The pronounced orange color of the fat made it desirable to conduct a few tests to get some idea of the composition of the material.

The tag attached to the sample of blubber reads as follows: "Orange blubber from back of carcass of fur seal, ♂ ca. 3 yr. old. St. Paul I. Alaska 27 VII 50 V. B. Scheffer." A small amount of the blubber (about one gram) was ground with reagent grade sand and the lipids brought into solution following Bloor's method (Bloor, New York, Reinhold, 1943). The extract was analyzed for total cholesterol and phospholipid. Another sample of blubber (29.085 grams) was refluxed for eight hours in Bloor's mixture. After this the pieces of the tissue were shredded in an electrical blender-mixer and refluxed in fresh solvent for four more hours. The two solutions were mixed. Upon cooling appreciable orange-colored oil fell to the bottom of the flask. The extract had a pronounced yellow-orange color.

Spectral transmission curves for samples of the raw extract were plotted, for wave lengths

between 400 and 700 millimicra. A portion of the extract was boiled with concentrated hydrochloric acid and then a spectral curve obtained for the resulting solution.

The results of the lipid analyses are as follows: total phospholipids, 4.3 per cent of the fresh blubber; total cholesterol, 0.24 per cent. Table 1 shows the results of the spectrophotometric studies. Figure 1 illustrates the spectral-transmission curves obtained with the raw lipid extract (broken line) and with the hydrolyzed extract (solid line).

Discussion.—It is known that cholesterol is the only sterol which occurs in any appreciable quantities in marine animal oils generally. Consequently it is safe to assume that the 0.24 per cent sterol in the fur seal blubber is all cholesterol. This value is of the same order of magnitude as those for the sperm whale head oil (0.2 per cent cholesterol in the oil) and the dolphin blubber oil (0.2 per cent unsaponifiable matter which is mostly sterol).

TABLE 1.—*The per cent transmission and the optical density of the blubber extracts at different wave lengths* (λ) *using cuvettes of 24 mm. and 19 mm. diameter, respectively. Reference, Bloor's mixture*

λ IN mμ	PER CENT TRANSMISSION		OPTICAL DENSITY	
	24 mm.	19 mm.	24 mm.	19 mm.
400	77	83	.11	.08
500	85	90	.07	.05
600	98	100	.01	.00
700	98	100	.01	.00
450	80	86	.10	.07
550	95.5	98	.02	.01
650	99	100	.01	.00
425	81	86	.09	.07
475	81	85	.09	.07
440	80	—	.10	—
460	80	—	.10	—
525	91	—	.04	—

TABLE 2.—*Phospholipid values from the literature (Bloor, loc. cit.). Values in per cent fresh tissue*

ANIMAL	MUSCLE	BRAIN	LIVER
Horse	1.7	5.1	3.7
Rat	1.1	6.1	2.9
Dog fish	1.1	4.7	1.7

On the other hand the harbor seal blubber oil and the blubber oil from Steller's sea lion contain about 1.4 per cent unsaponifiable matter (Brocklesby, Fisheries Res. Bd. of Canada, Bull., 59, 1941).

The amount of phospholipid in the fur seal blubber (4.3 per cent) seems high if compared with values for various animal tissues (Table 2). However, a sample of German whale oil has been reported to contain 4.3–6.8 per cent lecithin, and the egg oil of various marine fish may have as much as 18 per cent lecithin (Brocklesby, *loc. cit.*). Whether the large amount of phospholipid in the blubbers of these marine mammals is associated with a high rate of fat turnover at the depots cannot be decided, but it is a possibility to consider.

The values in the present work are interesting in relation to the published values for ground squirrel subcutaneous fat: cholesterol, 0.1 per cent; phospholipid, 0.25 per cent (Wilber and Musacchia, Jour. Mamm., 31: 304–309, 1950). Apparently depot fat from marine

mammals is consistently different from that in land animals (Hilditch, New York, Wiley, 1947).

Figure 1 shows that the lipid material in alcoholic solution has a strong absorption band between about 440 and 475 millimicra. After hydrolysis with hydrochloric acid, this band disappears. Otherwise the two curves are practically superimposable.

There are a variety of carotenoids which color the oils from different marine animals. In all probability one of them is responsible for the orange-colored blubber in the fur seal. On the basis of the available information it is not possible to identify the specific compound, however.—CHARLES G. WILBER, *Biological Laboratories, St. Louis University, St. Louis, Missouri.* *Received August 6, 1951.*

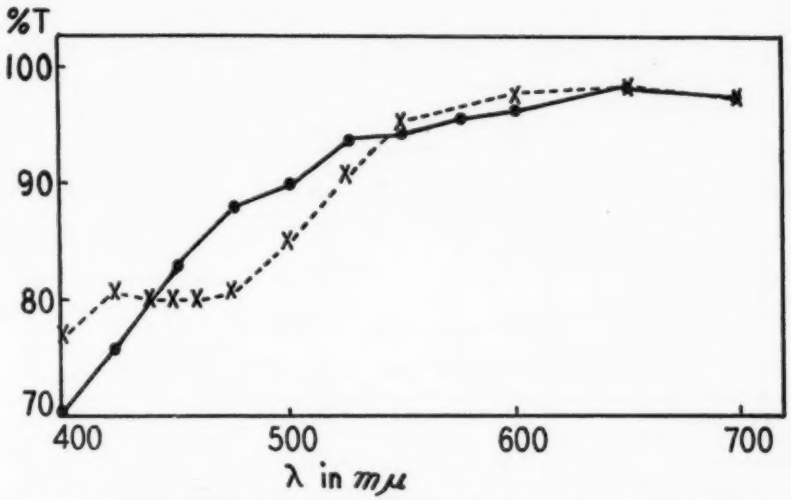

FIG. 1.—Spectral-transmission curves prepared for solutions of fur seal blubber in absolute alcohol. Prepared by plotting wave length in millimicra against per cent transmission as indicated on the scale of the Coleman 6A spectrophotometer. Absolute alcohol reference. Broken line, raw extract; solid line, after hydrolysis with hydrochloric acid.

RATE OF EXTRUSIVE GROWTH OF INCISORS OF POCKET GOPHERS

The incisors of rodents and rabbits are permanently-growing (rootless) teeth. The continuous growth permits them to replace abrasive wear at the chisel-like tips. Although the thin layer of enamel on the outer surface of incisors is the hardest mammalian tissue, the manner in which the incisors are used by rodents subjects them to rapid wear (and occasional breakage), hence, they need continued rapid replacement. Since the rate of incisor growth should depend on the nature of their use, it was thought that such teeth must grow rapidly in the pocket gopher, because gophers make frequent use of incisors when digging in hard soil and in removing rocks and other items that obstruct their numerous excavations.

Two pocket gophers (*Thomomys bottae*) from irrigated alfalfa fields were housed in cages containing several inches of soil, and were fed rolled oats, laboratory pellets, and occasionally green alfalfa, carrots, and potatoes. The animals maintained normal weights while in captivity.

By use of a dental engine and 7/8-inch coarse carborundum-steel disc, a fine transverse

notch was made on the enamel of each incisor close to the gingival margin. After sufficient tooth growth had occurred, another notch was made, again near the gum, and the interval between the two was measured with a vernier caliper reading to 0.1 mm. Additional notches and measurements were made as needed during a period of 88 and 67 days, respectively, for the gophers used.

The extrusive growth rate for the labial surface of each upper incisor averaged 0.62 (0.54–0.68) mm. per day or 8.91 inches per year. For each lower incisor it was 0.99 (0.89–1.05) mm. per day or 14.19 inches per year (Table 1). The rate of extrusive growth of all four incisors in these pocket gophers was 226 per cent of that of albino rats, 255 per cent of domestic rabbits, 280 per cent of guinea pigs, and 374 per cent of the rate of growth of incisors in porcupines.

TABLE 1.—*Rate of extrusive growth of incisors in rodents and rabbits*

KIND OF ANIMAL AND NUMBER USED	MILLIMETERS PER DAY		INCHES PER YEAR			REFERENCE
	Each Upper	Each Lower	Each Upper	Each Lower	All 4 Incisors	
Porcupine (18) *Erethizon dorsatum*	0.19	0.25	2.65	3.55	12.4	Shadle, Ploss, and Marks (1944)
Guinea pig (46) *Cavia cobaya*	0.25	0.31	3.75	4.63	16.5	Shadle, Valvo, and Eckhert (1938)
Guinea pig (27) *Cavia cobaya*	—	0.71	—	10.20	—	Dalldorf and Zall (1930)
Domestic rabbit (38) *Oryctolagus cuniculus*	0.29	0.34	4.14	4.94	18.1	Shadle (1936)
Albino rat (6) *Rattus norvegicus*	0.27	0.33	3.90	4.72	17.2	Marshall (1921)
Albino rat (?) *Rattus norvegicus*	—	0.40	—	5.75	—	Downs (1931)
Albino rat (10) *Rattus norvegicus*	0.31	0.40	4.45	5.75	20.4	Addison and Appleton (1915)
Albino rat (40) *Rattus norvegicus*	0.30	0.42	4.30	5.95	20.5	Shadle, Wagner, and Jacobs (1936)
Formosa rat (16) *Rattus losea*	0.32	0.44	4.54	6.36	21.8	Huruhata (1940)
Albino rat (8) *Rattus norvegicus*	—	0.45	—	6.47	—	Smith (1934)
Pocket gopher (2) *Thomomys bottae*	0.62	0.99	8.91	14.19	46.2	Howard and Smith

The average upper incisor produced only 63 per cent as much extrusive growth as the average lower incisor. The differential rate of incisor growth for the other mammals listed in Table 1 was about as follows: albino rat, 71 per cent; porcupine, 76 per cent; guinea pig, 81 per cent; and domestic rabbit, 85 per cent.

Pocket gophers probably make greater demands on their incisors than do many other species of rodents and rabbits, hence, the more rapid rate of extrusive growth. On range lands where gophers occur, they excavate more soil than all other species of rodents combined. That gophers frequently use their incisors while excavating burrows was learned by observing animals in dirt-filled glass-sided cages. Whenever an individual encountered soil too firm to dig with its claws, the material was promptly chiseled free with the incisors. Rocks were pulled free and carried from the tunnel with the incisors. These teeth are also

used when fighting, in cutting roots, stems, and tubers, and while gathering hay from above ground.

Because of its structure (enamel on outer surface and softer dentine behind), a rodent incisor wears unevenly, making the tooth chisel-shaped and adapted for gnawing. Caged rodents are often observed grating the upper incisors against the lowers, a practice that keeps the teeth sharp and prevents them from becoming too long.

When an opposing pair of incisors fails to meet, as the result of a foreign substance lodging between them or by malocclusion from some other cause, extrusive growth continues unhindered. The upper incisors then may grow until they penetrate the roof of the mouth and the brain. Malocclusion may also result in starvation of the afflicted animal if it can no longer close its mouth.

The explanation for the differential rate of extrusive growth between the upper and lower incisors in gophers is not known. There is no correlation between the rate of extrusive incisor growth and the differential rate of growth between the upper and lower incisors for the species listed in Table 1. Some possible explanations as to why the lowers grow faster than the uppers in pocket gophers are: (1) that the lower jaw moves, the upper is stationary; (2) that the animals can obtain more leverage with the lowers, hence more abrasion; (3) the lowers are longer, straighter, and able to separate slightly, which may result in greater chipping and breakage; (4) the lowers are not as hard as the uppers (no evidence available); and (5) the manner in which uppers and lowers rub each other results in greater wear of the lowers (This is a necessary interpretation if the lowers are not worn more rapidly than the uppers by other means).

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LATENT PERIODS OF AUDIOGENIC SEIZURES IN MICE

The latent period of an audiogenic seizure, i.e., the time elapsing between the beginning of stimulation and the start of the wild running phase of the seizure, is of fundamental interest in the study of the physiology of audiogenic seizures. In a previous paper (Frings,

et al., Jour. Mamm., 32: 60–76, 1951), we noted that the seizural latent periods for three strains of mice (Mongrel Albino, *dba*, subline 1, and *C-57*, subline 6) were significantly lower in the middle than at the beginning or the end of a sequence of seizures. This accorded with the observation by Morgan (Jour. Comp. Psychol., 32: 267–84, 1941) for the rat that latency decreased as the number of regular seizures increased. It has been reported, also for the rat (Galambos and Morgan, Jour. Exp. Psychol., 32: 435–42, 1943; Morgan, *loc. cit.*), that the latency is not related to susceptibility, intensity of stimulation, frequency of sound employed, previous ineffective stimulations, age or sex of the animals, or the amount of applied stimulus energy.

Further work in our laboratory, however, using stocks selected for high and low seizure susceptibility, indicated that the latency of seizures in mice is related to the innate susceptibility as well as to the number of regular seizures (Frings *et al.*, Jour. Mamm., 33: 80–87, 1952). This has been reported by Fuller *et al.* (Genetics, 35: 622–32, 1950) for inbred lines of mice. They concluded that the data they obtained were "wholly consistent with the hypothesis that average seizure latency is an index of physiological susceptibility to audiogenic seizures." Since they used latent periods for first seizures only, they eliminated the effect of repeated testing.

It should be noted that the term, latent period, as used by Fuller *et al.* (*loc. cit.*) refers to the time elapsing between the beginning of stimulation and the start of a convulsion (convulsive latent period). Since the convulsive phase is preceded by the wild running phase, this latent period would be about 5–6 sec. longer on the average than the seizural latent period.

The purpose of the present study was to discover the effects, if any, of susceptibility, number of seizures, and intensity of stimulation on seizural latent periods in mice. In all, data were analyzed from 1206 animals, representing 337 litters, with a total of 6750 seizures.

This study was financed in part by the U. S. Air Force Air Materiel Command, Wright-Patterson Air Force Base, Dayton, Ohio, under Contract No. AF-33 (038)-786, and The John G. Vogel Memorial Research Fund.

Materials and methods.—All mice used in this study were Albinos reared in our laboratory. In each test group there were approximately equal numbers of males and females. The methods of handling and testing have been described in detail previously (Frings *et al.*, *loc. cit.*). Seizures were induced by subjecting the mice imprisoned in a wire mesh cage to a 10 Kc. note at an average sound pressure of 110 db. (re 10^{-16} Watts/sq. cm.). The animals were tested daily, except Sunday, from 15 to 50 days of age. Latent periods were recorded to the nearest second.

The first mice studied were offspring of parents whose backgrounds were unknown. These mice were termed random stocks, and their seizure susceptibility was variable. To compare with these, offspring of selected highly susceptible mice were tested. These were called high incidence stocks, for these animals had rather consistently high seizure records. All mice from these stocks were included in the data, however, regardless of their records.

Next, the records of mice which were of low susceptibility (having fewer than seven seizures in the testing period) were studied. These mice were individually selected on the basis of their records and did not represent low seizure stocks. Low seizure stocks usually had one or two individuals with many seizures, and the number of seizures of these individuals was often as great as the total from all the other mice, thus masking the results from the typical animals. To compare with the low incidence mice, records of mice with high seizure incidence from the same litters as those with low records were studied. For each of the high incidence individuals the latent periods of the same number of seizures were used as for the paired low incidence individuals. These were seizures that occurred in the middle of an unbroken sequence of more than fifteen.

To discover the effect of continued seizure incidence on the latent period, the first seizures are analyzed separately for each of the groups. To find the rate of attainment of the short latent period in the middle of a series of seizures, records of the high seizure stocks described above were analyzed seizure by seizure for the first seven seizures. To check the

observation we previously reported, that the last seizure in a series is also of longer latent period than the middle seizures, the records for the last seizures of a group of mice having more than eight seizures, but discontinuing seizures before the end of the testing period, were analyzed.

The effects of intensity on latent periods were studied with two groups of mice from high incidence stocks. The first group was subjected to the standard sound pressure (110 db.) from 15–22 days of age, and was then treated at 95 db. from 23–30 days of age, after which it was returned to 110 db. for six more days. The second group was treated until various ages at the standard sound pressure, and was subsequently treated at 95 db. Records for the two groups are combined in the report, since they were similar.

Results.—The results are presented in Table I. The descriptive terms applied to the groups of mice correspond with those used in the previous section. Since no significant sex differences were found, the records for males and females in each group are combined. The Coefficient of Skew was calculated from the formula: 3 (Mean − Median)/σ. All distributions were skewed toward the longer times, as might be expected with latent periods as short as many of these. All, likewise, were markedly leptokurtic, most specially the distributions for high incidence stocks and high incidence individuals. The first seizures are treated separately for most of the cases, because they had uniformly longer latent periods than those in the middle of a series. The decrease in number of mice in the sequential study was due to deaths and low incidence records for some individuals.

Interpretations and conclusions.—Even a cursory examination of the data would suggest that the latent period is related to the susceptibility of the mice. Thus, the low incidence mice had the longest latent periods and the high incidence stocks the shortest, with random stocks intermediate. Since, however, the latent period may be related to the number of seizures, it is important to discover whether the differences noted here may not be due to differences in seizure number. This is probably best eliminated by using latent periods for first seizures only. In this case, the random stocks and low incidence mice are approximately the same, while the high incidence stocks have significantly shorter latent periods. Our data, thus, support the conclusion of Fuller *et al.* (*loc. cit.*) that the latent period is related to the degree of susceptibility of the mice.

The latent period, further, seems to be related to the number of successive seizures, as Morgan (*loc. cit.*) reported for the rat. In all stocks, the latent period for the first seizure is significantly longer than for the middle seizures. In high incidence mice, if we omit the first few and the last few seizures in a sequence, the latent period is very short (9–11 sec.). This short latent period is attained by about the fifth or sixth seizure in the series. It is interesting to note that, after the first seizure, there were only two seizures in a total of 2765 with latent periods longer than 60 sec. Other groups gave comparable results. If the mouse loses its susceptibility before the end of the test period, however, the latent period increases near the end of the sequence of seizures. (Frings *et al.*, *loc. cit.*). In fact, it is usually possible to predict a day or two in advance that a mouse will stop having seizures by noting the lengthening of the latent period. Since these mice are still having regular seizures, this suggests that the seeming relationship to number of seizures may be simply a reflection of the fact that mice with many seizures are most susceptible in the middle of their period of regular seizure incidence. Thus, it is probable that the latent period is only secondarily related to the number of seizures and primarily related to susceptibility.

The latent period is obviously longer at a lower intensity of stimulation than at the standard intensity. However, at 110 db. the mice had seizures regularly, while at 95 db. most of the mice had scattered seizures. Since the results might be influenced by this fact, the latent periods of those having continuous seizures at 95 db., and of those with scattered seizures, are presented in the table. These are significantly different from each other, but also both are significantly longer than the latent period at 110 db. These data might be thought to suggest that the latent period is dependent upon both susceptibility and number of seizures. Since, however, the mice with scattered seizures were probably less susceptible than those with continuous seizures, the number of successive seizures may be merely a

TABLE 1—*Latent periods of audiogenic seizures in different stocks of mice*

GROUPS OF MICE	NO. OF LITTERS	NO. OF MICE	NO. OF SEIZURES	MEAN LATENT PERIOD ± STAND. ERROR, SECONDS	COEFFICIENT OF SKEW
Random Stocks (All seizures)	19	100	1145	27.1 ± 0.52	+0.80
Random Stocks (1st seizure)	19	100	100	36.0 ± 1.88	+0.99
High Incidence Stocks (All seizures)	29	207	3163	11.6 ± 0.18	+0.97
High Incidence Stocks (1st seizure)	29	207	207	24.6 ± 1.3	+1.1
Low Incidence Mice (All seizures)	36	80	398	29.9 ± 0.91	+0.73
Low Incidence Mice (1st seizure)	76	129	129	34.7 ± 1.8	+1.2
High Incidence Mice (Middle seizures)	36	80	398	11.3 ± 0.35	+0.38
High Incidence Stocks					
1st Seizure	29	207	207	24.6 ± 1.3	+1.1
2nd Seizure	29	191	191	18.4 ± 0.96	+0.84
3rd Seizure	29	191	191	14.5 ± 0.64	+0.68
4th Seizure	29	191	191	13.0 ± 0.64	+0.73
5th Seizure	29	174	174	12.4 ± 0.63	+1.05
6th Seizure	29	172	172	11.4 ± 0.64	+0.58
7th Seizure	29	170	170	10.3 ± 0.47	+0.59
Last seizure of selected mice	105	338	338	26.1 ± 0.90	+0.78
High Incidence Mice					
Tested at 110 db.	69	103	280	10.7 ± 0.37	+0.64
Tested at 95 db.	69	103	325	22.9 ± 0.64	+0.62
High Incidence Mice at 95 db.					
With regular seizures	26	37	186	20.1 ± 0.68	+0.49
With scattered seizures	40	61	106	26.5 ± 1.2	+0.17

reflection of susceptibility. In either case, the intensity of stimulation is critical in determining the latent period. This accords with our earlier report, and does not accord with the conclusions of Morgan (*loc. cit.*) for the rat. Perhaps this is a species difference; perhaps it is due to the small number of cases which Morgan used.

All the data presented herein, therefore, show that the latency of audiogenic seizures in the mouse is dependent upon susceptibility, number of successive seizures, and intensity of stimulation. The first two, however, are probably a reflection of susceptibility alone. These results fully support the hypothesis advanced by Fuller *et al.* (*loc. cit.*) that a seizure ensues when some substance or state accumulates at a rate too great for the normal removal mechanisms to act.

It is obvious that, if latent periods are to be used as indices of susceptibility, there must be control of the intensity of stimulation and of the number of successive seizures an animal has. It is not justifiable to compare latent periods for second or third seizures with those for first seizures, unless the comparison be made to determine the effect of repeated testing. With these precautions in mind, latent periods seem to offer the best and most easily obtainable measure of susceptibility of mice to audiogenic seizures.—Hubert Frings and Mable Frings, *Dept. Zool. and Ento., Penna. State College, State College, Penna.* *Received October 31, 1951.*

BATS AND BIRDS COMPETING FOR FOOD

On August 25, 1951, while studying mammals in the Graham Mountains, Graham County, Arizona, we observed swallows and pipistrelle bats competing for the same food. This was at the mouth of Grant Canyon, one mile northeast of Fort Grant, at an elevation of 5250 feet. Early in the evening, hundreds of violet-green swallows (*Tachycineta thalassina lepida*) were circling in the air along the rocky outcrop which borders Grant Creek, apparently catching insects. At 6:40 P.M., while it was still quite light, pipistrelles (*Pipistrellus hesperus maximus*) started flying down the canyon. The bats commonly flew in with the clouds of swallows, and on several occasions we saw both a bat and a swallow dive for what seemed to be the same insect. We could not ascertain which animal obtained the food, but generally the swallows seemed the swifter and stronger fliers. On one occasion we observed a swallow drive off a bat when both had gone after the same object of food. Six of the bats were shot, three of which were males. One violet-green swallow was also shot at this same time.

Pipistrelles may actively fly long after dawn, for on the mornings of August 25, 26, and 27, we observed them flying at 5:45 A.M. at the Jernigan Ranch, 11 miles east and 3 miles south of Bonita, at the base of the Graham Mountains. It had rained the night previous to each of these observations, and possibly the bats were forced to delay their feeding activities, for they were seen only on these mornings. The bats were flying toward the rocky outcrops, and two of them were shot each morning. All six were males.—Richard G. Van Gelder and Woodrow W. Goodpaster, *Museum of Natural History, University of Illinois, Urbana, Ill., and 6014 Kellogg Ave., Cincinnati, Ohio.* *Received November 19, 1951.*

LONGEVITY IN THE PIPISTRELLE, *PIPISTRELLUS SUBFLAVUS SUBFLAVUS*

Few observations have been published on longevity of *Pipistrellus subflavus*. Allen (Jour. Mamm., 2: 54, 1921) banded four gravid females of this species. Three years later he recovered three of the four, which were again gravid. The minimum age of these individuals was four years. Hitchcock (Canadian Field-Naturalist, 63: 56, 1949) recorded the recovery of two banded *P. s. obscurus*, both males, one at least one year old, and the second at least six years old.

On February 1, 1941, Dr. Fred R. Cagle and I banded 57 (46 males and 11 females) hibernating pipistrelles, *P. s. subflavus*, and released them in Morrison Cave, near Burksville, Monroe County, Illinois. To date, three of these bats, all males, have been recovered. One was killed by Mr. James Casey on the porch of a house in Crystal City, Jefferson County, Missouri (approximately 13 miles WSW of the point of banding), on July 7, 1941. The second

was recovered by Dr. Carl O. Mohr in "Eckerts Cave, near Burksville" on January 23, 1947. This bat was at least six and one-half years old. The third was recovered by Mr. Irving B. Sachs at "Eckhart Caves, vicinity of Burksville" and died in captivity on December 2, 1947. This individual was somewhat more than seven years old. I have been unable to determine whether "Eckhart Caves" or "Eckerts Cave" are the same as Morrison Cave, where these bats were banded.

I am grateful to Dr. Fred R. Cagle, Department of Zoology, Tulane University, New Orleans, Louisiana, who made the original banding data available to me, and to the United States Fish and Wildlife Service for furnishing the bands used and for informing me of reported recoveries.—E. LENDELL COCKRUM, *Museum of Natural History, University of Kansas, Lawrence, Kansas.* *Received November 26, 1951.*

THE BIG FREE-TAILED BAT IN OKLAHOMA

The big free-tailed bat, *Tadarida molossa* (Pallas) [= *Tadarida macrotis* of authors, see Hershkovitz, Proc. U. S. Nat. Mus., 99: 452, 1949], has been reported in North America north of Mexico from a few scattered localities as follows: California, 2 (Shamel, Proc. U. S. Nat. Mus., 78: 16, 1931, and Huey, Jour. Mamm., 13: 160, 1932); Nevada, 1 (Shamel, *loc. cit.*); Utah, 3 (Durrant and Setzer, Jour. Mamm., 24: 501, 1943); Arizona, 1 (Shamel, *loc. cit.*); Colorado, 2 (Smead, Jour. Mamm., 19: 104, 1938); Texas, 1 (Taylor and Davis, Texas Game, Fish, and Oyster Comm., Bull., 27: 21, 1948); Iowa, 2 (Scott, Iowa State College Jour. Sci., 12(1): 58, 1937); and British Columbia, 1 (Anderson, Nat. Mus. Canada, Bull., 102: 34, 1947).

On October 17, 1951, W. A. Kornelle found a young female of this species in a grainery on the George Hawkins farm, four miles south of Elkhart, Kansas, in Texas County, Oklahoma. The bat was taken to Mr. J. A. Drake, a biology teacher at the Elkhart Community High School, who sent it, alive, to me. The bat is now a specimen (no. 43165, skin, skull, and body skeleton) in the University of Kansas Museum of Natural History, and, to the best of my knowledge, represents the first occurrence of this species recorded for Oklahoma.—E. LENDELL COCKRUM, *Museum of Natural History, University of Kansas, Lawrence, Kansas.* *Received November 19, 1951.*

NOTES ON BEHAVIOR OF LONG-TAILED WEASEL IN UTAH

A demonstration by weasels, *Mustela frenata nevadensis*, of their apparent lack of fear of man was observed by two associates and myself at Payson Lakes, 8300 feet, in the Mount Nebo area, July 13, 1950. Two adult, male weasels (now University of Utah Museums specimens 7479 and 7480) were seen (at a distance of 30 feet) crossing a clearing, nipping, jumping, and rolling over each other in a playful manner, displaying no signs of ferocity or rage in their actions. They appeared quite unconcerned over our presence. As they approached a patch of false skunk cabbage (*Veratrum californicum*) one was shot, whereupon the other quickly darted into the patch. The dead weasel was placed in the middle of the clearing, and then we proceeded to beat with sticks and tramp the false skunk cabbage in an effort to drive the weasel into the open. Meanwhile the weasel we were hunting eluded us and was seen at the site of his dead companion playfully lifting and biting the dead weasel's carcass. When approached he grasped the dead weasel by the neck and proceeded to carry it off. After carrying the carcass for 15 feet he dropped it and attempted to seek cover in the patch of false skunk cabbage. As he entered the cover he was shot.

In addition to the apparent lack of fear of men, the aforementioned observations suggests that males are not always solitary as inferred by Hall (Mamm. of Nev., 1946: 190). RICHARD M. HANSEN, *Dept. Vert. Zool., University of Utah, Salt Lake City, Utah.* *Received December 3, 1951.*

SOME CHARACTERISTICS OF WOLVERINE FUR

There are many accounts describing the unusual quality of wolverine (*Gulo*) fur as a trim for parka and other garments used in arctic and sub-arctic regions. Most of these state

that the breath will not freeze on this fur and that this is the reason for its wide use by northern Indians and Eskimos.

During World War II thousands of military garments were trimmed with wolf and coyote fur to provide the desirable control of air currents in or out of the garments. As long as the fur trim can be kept dry, it functions quite well. However, once rime or frost has accumulated on wolf and coyote fur trim it cannot be brushed or shaken off. Therefore, in order to remove the rime, the garment must be warmed to the point where the rime either sublimates or passes through a liquid stage before it is evaporated. When air temperatures are low enough to cause direct freezing of the breath on the fur trim of garments, thawing caused by warm air currents from the body wets the fur. It thus becomes very uncomfortable to the wearer and also loses its ventilating quality. Here is the point of difference between wolverine fur and most other furs. Frost or rime actually will form on wolverine fur at subzero temperatures, but it can be readily brushed off with a simple flick of the mitten and thus the fur can be kept dry. If the rime is not brushed off, the fur will become wet and uncomfortable, just as other furs do. Raw wolf, coyote, and wolverine furs react to frosting and wetting as noted above. There is an indication that chemical tannage alters these reactions by reducing frost and moisture resistance.

Among the Canadian Eskimo, the "Husky" people, there is a custom of trimming parka hoods with both wolf and wolverine fur, used together. A strip of the long "mane" hair of the wolf pelt is sewed to the hood and then a strip of wolverine fur is sewed in front of the wolf fur around the parka hood. This creates a "sun-burst" effect with the rich dark color of the wolverine fur contrasted against the long silvery hair of the wolf mane. The usage of the wolverine fur is not entirely because of its frost-shedding quality. Many people use it because of its luxuriant color and texture and because of a comparative rareness which places it in somewhat of a trophy category.

During 1948, fur traders in the Mackenzie River district of Canada bought wolverine furs from "bush" trappers for an average of $12.00. Some of these furs were taken to barren land trading posts where Eskimos paid up to $70.00 for a single pelt. (Wolf pelts purchased by traders for $1.50 sold for $35.00 to Aklavik Eskimos in 1948.) Willingness of the Eskimo to pay so high a price for this item is based as much upon the beauty of the pelt as upon its other characteristics.—Horace F. Quick, *University of Maine, Orono, Maine.* *Received November 15, 1951.*

ORD KANGAROO RAT IN NORTH DAKOTA

In early November, 1949, William T. McKean obtained a kangaroo rat 10 miles north of Marmarth, Slope County, North Dakota. The specimen had been killed on the roadway and was partially crushed. McKean sent it to the Museum of Natural History for deposit and identification. It is an Ord kangaroo rat and is referred to *Dipodomys ordi terrosus* Hoffmeister on the basis of its dark color; the skull is crushed. Setzer (Univ. Kansas Publ., Mus. Nat. Hist., 1: 523, December 27, 1949) writes that this subspecies probably occurs in "extreme western North Dakota" and McKean's specimen (KU no. 35440) is, to my knowledge, the first kangaroo rat recorded from this state.—Rollin H. Baker, *Museum of Natural History, University of Kansas, Lawrence, Kansas.* *Received Nov. 7, 1951.*

THE KANGAROO RAT PREYED UPON BY THE SPARROW HAWK

Predation on nocturnal mammals by diurnal avian predators is rare, and the evidence for the act is usually derived from scat or stomach analysis. Few actual observations of such predation are reported. In this regard the following observation is of interest.

At 1315 on 23 November 1951 I flushed a male sparrow hawk (*Falco sparverius*) carrying prey near the Rodent Enclosures at the San Joaquin Experimental Range at O'Neals, California. It flew to a Blue Oak (*Quercus douglasii*) where, upon examination with 8× binoculars, the prey was seen to be a large adult kangaroo rat (*Dipodomys heermanni*). Blood was still dripping from the prey, indicating that the rat was not carrion. The hawk made no attempt to eat in my presence and soon flew away. The weight of the prey did not

affect its flight, although adult kangaroo rats may attain 60–70 grams in weight. Heavy rains had occurred in the preceding three days, soaking the ground in the swales, and probably flooded out any rats subsisting in this marginal habitat. These animals are extremely pugnacious and would likely drive out any invader attempting to settle in an occupied burrow. Fitch (Jour. Mamm. 29: 5–35, 1948) records the kangaroo rat in 0.9 per cent of 4661 nest prey and scat items of the red-tail hawk (*Buteo borealis*), a much slower and less agile species than the sparrow hawk. These observations were made in the same area that Fitch (*op. cit.*) made his studies.—HENRY E. CHILDS, JR., *San Joaquin Experimental Range, O'Neals, California. Received December 27, 1951.*

OBSERVATIONS ON THE YOUNG OF THE MERRIAM KANGAROO RAT

Although there have been numerous field observations on the young of *Dipodomys*, they rarely are observed in the laboratory. Usually they die of neglect soon after birth. Tappe (Jour. Mamm., 22: 117–48, 1941) has given a thorough and interesting account of the newborn young and early life of *Dipodomys heermanni tularensis*. Similar data for the other genera of heteromyid rodents are lacking.

Two pregnant *Dipodomys merriami merriami* were trapped near Llano Road, 3 miles northwest of Victorville, San Bernardino County, California, on August 29, 1951. Both specimens were brought into the laboratory and placed in separate 10 by 8-inch wire cages with metal bottoms. Rolled barley was used for food and a small roll of cotton was placed in each cage so that the prospective mother and her young could keep warm and be shielded from the light. The cages were covered with a few layers of cheese cloth and placed in the darkest corner of the laboratory.

During the night of August 30 both females gave birth to young. One litter of three was found dead on the floor of a cage. Their weights were 3.2, 3.5, and 3.8 grams, respectively.

The other litter of two survived. To avoid disturbing them, they were not measured or weighed. Their progress was followed during the month of September and early October.

Litter size in kangaroo rats is small in comparison with most rodents. Tappe (*loc. cit.*) cites instances where litters of four have been born to *D. h. tularensis* and *D. h. jolonensis*. Vorhies and Taylor (U. S. Dept. Agric., Bull. 1091, 1922), in their study of *Dipodomys spectabilis spectabilis* in Arizona, found that of 67 females examined, 15 had but one offspring each; 52 had but two each; while only two individuals had three. Vorhies and Taylor (*loc. cit.*) and Grinnell (Univ. Calif. Publ. Zool., 24: 1–109, 1922) indicate that two is the usual number in a litter of *D. m. merriami*. Nine litters of *D. m. merriami* have been born either enroute to, or in, the writer's laboratory, and of these, one contained three young, while the others contained two each.

The adult *D. h. tularensis* is a much larger animal than is the adult *D. m. merriami*. Tappe (*loc. cit.*) found the weight of four newly born *D. h. tularensis* to be 3.4, 3.5, 3.8 and 3.9 grams, which is similar to weights observed for the smaller *D. m. merriami*. Tappe also states that the tail of *D. h. tularensis* at birth is relatively short, slightly more than one-half the length of head and body. In *D. m. merriami* the mean tail length of the three young was 16 per cent greater than length of the body.

The young were hairless until the sixth day when a sparse scattering of fine hair appeared on the back of the body and top of the head. On the 11th day fine short hairs uniformly covered the distal 10 millimeters of the tail. Tappe (*loc. cit.*) indicates that *D. h. tularensis* showed first evidence of hair on the body and head on the third day and on the tail as early as the ninth day. In *D. merriami*, the external ears, which were closed at birth, opened on the 16th day, which is the same as in *D. h. tularensis*. The eyes opened on the 21st day, which is much later than the 14–15 days reported for *D. h. tularensis* by Tappe. On the 30th day the two young were seen climbing on the sides of the cages and had assumed the usual caged activities of the adult. They ate small bits of rolled barley on the 32nd day, they were then taken from their mother and placed in individual cages. On the 42nd day, ten days after weaning, both juveniles died. It is assumed that death was due to heat, since the temperature in the laboratory reached 37 degrees centigrade on three successive days.

The adult female weighed 38.2 grams the day after the young were born and dropped to 27.7 grams at the time the young were weaned. This drop in weight can not be attributed to dietary deficiency since other non-pregnant females of the same subspecies have not been observed to lose this much weight when placed on the same diet.—David J. Doran, *Department of Zoology, University of California, Los Angeles.* *Received December 24, 1951.*

RED-BACKED VOLE WITH A TICK ATTACHED NEAR EYEBALL

A red-backed vole (*Clethrionomys gapperi*), with a tick attached to or just under the inner corner of the eyelid at the canthus, was caught in a live trap on July 11, 1951. This is an unusual place of attachment and it is difficult to understand how the tick could have become attached at a point where it could easily be scratched off by either the forefoot or hind foot of the vole.

The engorged tick was attached in such a manner that close examination and moving of the tick might injure the eye. The eyelids were nearly closed, leaving only a narrow slit through which the eyeball appeared glassy. The hair immediately surrounding the eye had been scratched off. The vole was sluggish. On July 13, the vole was recaptured and the tick had dropped off. The vole seemed more active, but the eye was still slightly milky in appearance. The vole, retrapped again on August 1, appeared normally active, the eye appeared normal and the hair around the eye had regrown. It was evident that the tick depressed the vitality of the vole, yet the vole seemed to completely recover.—Harvey L. Gunderson, *Museum of Natural History, University of Minnesota, Minneapolis 14, Minn.* *Received December 8, 1951.*

NOTES ON THE BURROWING AND FOOD HABITS OF THE OLYMPIC MARMOT

In investigating the burrows of *Marmota olympus*, the authors are indebted to Mr. Preston Macy, Director of the Olympic National Park, and to Mr. Gunnar Fagerlund, Park Naturalist, for his suggestions regarding probable location of colonies and methods of capture.

The investigations were made during the summer and fall of 1950, on Hurricane Ridge, Clallam County, Washington. A colony was located on the north side of the Ridge, 2½ miles west of Obstruction Point, where there is a junction of the Moose Lake trail with the road. Other colonies were observed on the south side of the Ridge, but the animals had retreated from the road, and had dug their burrows among the trees. Isolated burrows were seen occasionally on both the north and south sides of the Ridge, and in all cases except two these isolated burrows were among the trees away from the road.

Detailed investigation was confined to the colony on the north side of the Ridge 2½ miles west of Obstruction Point. There were, in this colony, 12 or 15 animals. An exact count was impossible due to the large numbers of burrows in which no marmots were seen. Where the colony extended down over the hillside, onto a very steep slope, the burrows were inaccessible.

The old adult whose burrow was the highest served as the sentry for the colony. We presumed this animal to be a male, since no young were near. In attempting to capture the marmots, traps were set and camouflaged in the mouths of the burrows. The marmots showed themselves to be extremely clever and intelligent. Five traps of the spring type, assorted sizes, were set and camouflaged in the mouth of one burrow. The marmot came up to the traps and sniffed about for a few minutes. He then put his paws between the spring arms and the pans of the traps and came out into the air without difficulty. He went back in, then repeated this feat five times. He did not set off any of these traps nor did he even disturb the chains.

Baiting was attempted without success. Apples, rolled oats, and prunes were ignored by the marmots. Carrots were gnawed and bitten if laid near the burrows, but remained untouched when placed near the traps. Potatoes were also bitten, but not when placed on or near the traps.

One animal blundered into one trap, and put up a terrific fight, with much growling and struggling. He succeeded in twisting the chain off the ring, and retreated down the burrow taking the trap with him.

Home-made nooses were tried. Snares were set in the burrows, and observations were made. The marmots were cautious, approached, sniffed about, and then pushed the wires aside. Snares were successful only when they were held in the mouth of the burrow, and then jerked shut as the marmot first put his head out in the morning. By this method we captured one young marmot. His mother was snared, but the wire broke during her struggles for freedom before she could be seized by hand. The young marmot was kept in captivity from October to February, and did not go into permanent hibernation. He went into a sleep for two days in January when the temperature went below 10° above zero F.

The marmots had not gone into hibernation on October 23, although the plants were dead, and some snow lay on the ground. It had been freezing during the nights in the mountains at that elevation, approximately 5000 feet above sea level. The rangers reported night frosts preceding that date. At this time the marmots were coming out later in the morning, 11:30 being the average for one morning. They went in for the night earlier, retiring about 4:30 to 4:45. In July, the animals came out between 7:00 and 8:00 in the morning, retreated down the burrows from 12:00 to 2:30 approximately, during the heat of the day, and remained out until 8:00 and 9:00 in the evening.

In digging out the burrows, some interesting facts were observed regarding the living habits and the burrows of these animals. The food in the burrows consisted of sedges, lupines, lilies, and some Composites. and other plants tentatively identified as members of the Cruciferae. Sedges and lupines were present in much larger amounts than the other plants. The animals had been observed earlier in the summer eating miner's lettuce, heather blossoms, moss, and sedges outside their burrows.

The burrows followed the general contour of the hill, keeping the same distance below the surface, and paralleling the rise of the hill. Short burrows were found, evidently used as toilets. Here the dung was four or five inches deep, with no plant covering of any kind over it. In the regular burrows of greater length, where dung had dropped, plants were always found laid over it. Side burrows were present, but were usually short in length. Layers of plant material were found in most of the chambers. On the bottom would be a layer of roots, then above this a layer of shoots. The pile of vegetation compared favorably with that of a compost pile. It would often be 12 to 15 inches deep. This was the only type of stored food found in any of the burrows.—ALEX BELTZ AND ERNEST S. BOOTH, *Department of Biological Sciences, Walla Walla College, College Place, Washington.* *Received October 27, 1951.*

AN ALASKAN RECORD OF THE NARWHAL

An unreported record of the Narwhal, *Monodon monoceros*, is represented in the collection of the San Diego Society of Natural History by a complete skull and tusk, No. 7096, collected by an Eskimo near Cape Halkett, Harrison Bay, at the mouth of the Coville River, Latitude 71° N., Longitude 151° W., on the northern coast of Alaska, during the summer of 1928.

The skull of this male specimen was sent, dried but with meat still attached, to the Society by the late Charles D. Brower, of Point Barrow fame, and was cleaned in the Museum's laboratory by the writer. The tusk measures 1430 mm. or approximately 4 feet 8 inches in length with the tip broken off and missing.

At the time Mr. Brower sent the specimen he wrote that "the Narwhal is so seldom seen in the northern Alaskan waters that the local eskimos have no name for it." He further stated that "this specimen is only the second one he had seen in over forty years."

That this mammal is of rare occurrence in northern Alaskan waters is further substantiated by perusal of the indices of the Journal of Mammalogy where in many accounts of arctic mammals only two references are made of this species in the 32 volumes, and neither apply to Alaskan records.—LAURENCE M. HUEY, *San Diego Society of Natural History, Balboa Park, San Diego 1, California.* *Received November 5, 1951.*

A LIVE TRAP FOR GROUND SQUIRRELS

In his paper, "Summary of Investigations of the Ecology of Harmful Rodents in the USSR During 20 Years (1917–1937)" (Zoologitcheskij Zhurnal, Vol. XVI (5), pp. 950–971, 1937), N. I. Kalabukhov refers to a live trap for ground squirrels, called "Donetzkaja," which had been proposed by Walkh in 1925. I have not been able to refer to Walkh's papers, but the name, standing for a region in Ukraine, and the method of employment remind me of the live trap long in use there for ground squirrel eradication. As far as I can learn, this trap is unknown in the United States. The ease with which it can be made and its efficiency in catching ground squirrels might make this trap useful to interested mammalogists in this country.

The trap (Fig. 1) has the form of a helix, made from iron or steel wire. A convenient diameter of the wire for traps for small species of ground squirrel has been found to be 2.5 mm. The diameter of the trap must be slightly smaller than the diameter of the squirrel's burrow. The separate turns of the helix are prevented from straightening by interlacing on three or four sides with thin soft wire, 0.5–0.7 mm. in diameter (Fig. 1A). The trap must be somewhat longer than the body of the ground squirrel. One end of the helix must be closed, so that the animal will not be able to go through. This can be simply done by making the last turn of the helix much smaller, and by interlacing with thin wire. At the other end, the entrance, the first turn of the helix must be 2–3 mm. smaller than the other. In this way a wire loop or "tongue" attached on one side of this turn can be easily opened into the trap, but is prevented from opening out (Fig. 1B).

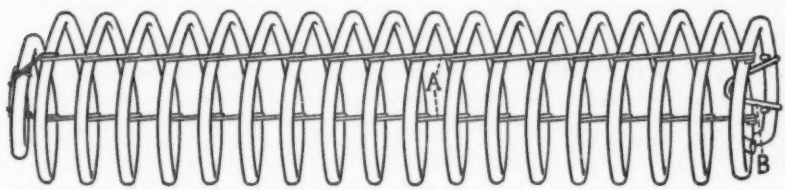

FIG. 1.—Bottom view of trap; opening at right

In use, the trap is placed with its opening within the entrance of a burrow, so that an animal leaving the burrow must enter the trap. The wire "tongue" can then fall into place and prevent the animal from escaping.—W. PRYCHODKO, *Detroit Institute of Cancer Research, Detroit 1, Michigan. Received October 29, 1951.*

HOW EFFICIENT ARE SNAP TRAPS IN TAKING SMALL MAMMALS?

Our concepts of the abundance of small mammals are usually derived from the frequency with which they are taken in traps. Thus, some genera such as *Microsorex*, *Phenacomys*, and *Synaptomys* are considered to be rare in most places where they occur because they are not often trapped in numbers. By comparison, *Peromyscus*, *Clethrionomys*, *Microtus*, *Sorex*, and *Blarina* are often trapped in numbers and hence are generally considered as common.

Many workers engaged in small mammal collecting or population studies are aware that their methods for taking small mammals may be selective of some genera. It is generally agreed for example that ordinary snap traps take *Peromyscus* efficiently, but that *Synaptomys* is often taken in such traps more by accident than by any attraction to the bait. Again, C. H. D. Clarke (Natl. Mus. Canada, Bull. 88 (Biol Ser. 23), King's Printer, Ottawa, 1938) in his study, used both snap traps and buckets sunk flush with the ground and partly filled with water. In comparing the two traps he found that bucket traps were more efficient in taking jumping mice and small shrews, while *Peromyscus* and *Blarina* seemed to avoid them. After six years of experience with these two kinds of traps, the writer has found that bucket traps often take *Napaeozapus*, *Zapus*, *Phenacomys*, *Synaptomys*, *Sorex*, and

Microsorex when intensive use of snap traps either fails entirely to secure these genera, or produces only small numbers.

By accident the writer obtained another illustration of the limited efficiency of ordinary snap traps in taking some small mammal genera. On August 11, 1949, in Manning Park, British Columbia (Lat. 49°00′N, Long. 120°30′W), approximately one-fourth mile of narrow gravel road was heavily oiled. Pools of oil up to an inch deep collected in some ruts. The following day fourteen mammals were found dead and mired in the oil. Some were completely plastered with the material and had to be pried from the road. After cleaning the animals with naptha gas, certain identification was not usually possible without examining the skull. The numbers and species of mammals taken from the oil were: *Phenacomys intermedius*, 7; *Peromyscus maniculatus*, 3; *Synaptomys borealis*, 2; *Microtus oregoni*, 1; and *Tamiasciurus hudsonicus*, 1.

For the rest of the month a limited number of snap traps, baited variously with walnuts, peanut butter, and cheese, were set along this road, never more than twenty feet from it. This work was aided by Dr. I. McT. Cowan. In a total of 129 trap-nights the following mammals were taken: *Sorex* spp., 10; *Clethrionomys gapperi*, 7; *Peromyscus maniculatus*, 2; and *Eutamias amoenus*, 2.

It is noteworthy that the snap traps did not take either *Phenacomys* or *Synaptomys*, two genera found in the oil but not trapped, and generally considered difficult to trap. While the catch in the oiled road suggested *Phenacomys* as the most abundant small mammal, the traps took none. On the other hand, *Sorex* and *Clethrionomys* predominated in trap captures, but none was taken in the oil.

There appears to be some basis for questioning the statements of some writers on the relative abundance of kinds of small mammals, for trapping method as well as actual population density may determine the number of each kind taken. There is no more reason why one trapping method should have equal success with all small mammalian genera than there is for one method being equally successful in taking all fur-bearing mammals.—R. York Edwards, *B. C. Forest Service, Victoria, B. C. Received November 24, 1951.*

A NEW POCKET GOPHER FROM THE NORTH RIM OF THE GRAND CANYON, ARIZONA

Thomomys bottae boreorarius, ssp. nov.

Type.—Adult female, skin and skull, number 1184, Hancock Foundation Collections, University of Southern California; taken at Swamp Point, 7522 ft. alt., 18½ mi. northwestward of Bright Angel Point, North Rim of the Grand Canyon, Coconino County, Arizona; July 10, 1947; Floyd E. Durham; original number, 2141.

Distribution.—Known from the type locality and vicinity which includes Muav Saddle, 6717 ft. alt., ½ mi. to the westward, and thence northward ⅔ mi. down Saddle Canyon as far as Powell Spring, 6209 ft. alt.; also the northeast end of Powell Plateau, 7650 ft. alt., which point is about 1 mile west of the type locality.

Diagnosis.—Size: medium to small, tail relatively short. Color: above tawny, brighter (ochraceous buff) on sides and darker mid-dorsally; ventrally slate-gray overlaid, particularly anteriorly, with buffy rufous; auricular patches black; distal ⅓ to ½ of tail whitish, basal part buffy; chin white; conspicuous white markings on lower face and in cheek pouches; feet and wristlets white; sides of mouth, nose, and rostrum blackish to dark brown, which color tends to continue posteriorly, somewhat darker than mummy brown, to form a broad, dark, mid-dorsal stripe which disappears before reaching the tail. Skull: small, short, and but little angled and ridged; bullae and brain case well inflated; rostrofrontal region convex dorsally in both longitudinal and transverse planes; zygomatic arches weak, narrower anteriorly, and smoothly curved; upper incisors weak and not procumbent; premaxillary bones extend well posterior to base of nasals (see measurements). The sides of the rostrum are straight and parallel and there is no distinct crest or flare overhanging the infraorbital fossa.

Measurements.—The first of each series of numbers is from the type, the second and

third are the averages of nine adult females (exclusive of the type specimen) and of two adult males, respectively, which specimens were obtained from the area of known occurrence; total length, 210, 203, 221; tail vertebrae, 66, 62, 68.5; hind foot, 29, 27.4, 29.5; ear, 5 (from notch, 5), 3.7 (4.2), 4 (4.5); weight in grams (none pregnant), 101, 89, 122. Skull: condylobasal length, 36.1, 34.4, 37.6; zygomatic breadth, 21.6, 20.8, 23; mastoidal breadth, 17.8, 18, 19.8; interorbital constriction, 6.3, 6.3, 6.4; length of nasals, 12.2, 11.7, 13.3; length of rostrum (taken from the middle of the anterior border of the nasals to the maxilla at its lateralmost point of union with the hamular process of the lacrimal), 15, 14.4, 15.9; alveolar length of maxillary tooth row, 7.6, 7.2, 8; extension of premaxillae posterior to nasals, 2.1, 1.9, 2.3, respectively.

Comparisons.—This race shows relationship to certain adjacent races of *bottae* pocket gophers (*trumbullensis*, *planirostris*, and *absonus* in northern Arizona) in the marked extension of the premaxillary bones beyond the nasals and in the white-tipped tail. *T. b. boreorarius* is nearest *absonus* to the northeast in size (herein meaning length of head and body) and similarity in size of sexes (females about 92 per cent as large as males). It is smaller than the races *trumbullensis* and *planirostris* to the westward and northward, respectively; the males of *boreorarius* are about 92 per cent as large as the males of the two latter races, and the females of *trumbullensis* and *planirostris* are 88 per cent as large as the corresponding males. *T. b. boreorarius* differs from the three above races in having a smaller and less angled and smoother skull with lighter zygomatic arches and upper incisors which do not extend beyond the nasals, white markings around the lower face, and feet white rather than colored like the dorsum. The evenly convexly curved longitudinal and transverse profiles of the rostrofrontal region distinguish the skulls of *boreorarius* from those of *trumbullensis* and *planirostris* (in which races they are flat to concave). Crests on the sides of the rostrum at the origin of the zygoma are inconspicuous in the new race whereas they are weakly developed in *absonus* and conspicuous in *trumbullensis* and *planirostris*. In general coloration, the tawny specimens of *boreorarius* are separable from the blackish *trumbullensis*, from the tan *planirostris*, and from the grayish *absonus*. In several characters (small size, reddish color, and white markings on lower face) *boreorarius* resembles specimens of *fulvus* taken on the South Rim of the Grand Canyon, but is separable from them on the basis of the greater extension of the premaxillaries (1.5 mm. in *fulvus*); less ridged and less angled skull; weaker, less procumbent upper incisors; shorter nasals and rostrum; less sexual dimorphism; and white-tipped tail. The tail of *boreorarius* is relatively short (less than 31.5 per cent of total length) as in *fulvus* and *trumbullensis*, whereas the tail is longer (32.5 per cent or more) in *planirostris* and *absonus*.

Specimens examined.—Sixty-two as follows: *T. b. boreorarius:* from the North Rim of the Grand Canyon, Coconino Co., Arizona, Swamp Point (type locality), 3; Muav Saddle, 5; Powell Spring, 9; Powell Plateau, 2. *T. b. trumbullensis:* from Mt. Trumbull, 3–4 mi. S Nixon Springs, Mohave Co., Arizona, 13 (topotypes). *T. b. planirostris:* from Washington Co., Utah, Zion National Park, 8; Washington, 1. *T. b. absonus:* from Jacobs Pools, House Rock Valley, Coconino Co., Arizona, 4 (topotypes), near east entrance to Zion National Park, Cane Co., Utah, 1. *T. b. fulvus:* from Coconino Co., Arizona, Little Springs, 11 (topotypes), near Grand Canyon on the South Rim, 5.

Remarks.—The new name, *boreorarius* (*boreas*, north, and *ora*, rim), means "of the North Rim." It is further descriptive of the habitat of this race in that these pocket gophers live at the edge of the "northern" or "forest" area, typical of the Kaibab Plateau, where the chaparral of the Upper Sonoran Zone of the canyon wall intermingles with the yellow pines in the Transition Zone.

Acknowledgments.—I wish to thank the following for the loan of comparative specimens: Dr. Seth B. Benson, Museum of Vertebrate Zoology; Mr. Stanley P. Young, U. S. Fish and Wildlife Service; and Dr. Thomas R. Howell, Donald R. Dickey Collection.—FLOYD E. DURHAM, *Allan Hancock Foundation, University of Southern California, Los Angeles.* *Received March 18, 1952.*

(Contribution of the Allan Hancock Foundation no. 96)

A NEW RACE OF RED-BACKED VOLE (*CLETHRIONOMYS*) FROM THE BARREN GROUNDS OF CANADA

The red-backed voles of the *rutilus* group range across arctic and sub-arctic America from Alaska to Hudson Bay. Formerly the North American populations were considered to be, or accepted as, a separate species (*dawsoni*) from related populations (*rutilus*) in Asia (Orr, 1945; Anderson, 1946). Recently, however, Rausch (1950), after studying the American and Asiatic forms, decided that the two species were conspecific. The writer has not studied this problem and follows the latest revision of the group by Rausch as have other investigators (Quay, 1951; Banfield, 1951).

The new race described here is based on a series of specimens collected in 1949 while Paul Queneau of Fairfield, Connecticut, Peter Scott of England, and the writer were engaged in a geographical and biological investigation of the Perry River area of the District of Mackenzie, Canada. The expedition was supported chiefly by the Arctic Institute of North America with funds supplied by the Office of Naval Research. A general account of the expedition has been published by Peter Scott (1951).

I take pleasure in naming the new race after Dr. A. L. Washburn, Director of the Washington Office of the Arctic Institute. I am indebted to Stanley P. Young of the U. S. Fish and Wildlife Service and Dr. W. J. Breckenridge of the Minnesota Museum of Natural History for the loan of specimens, and to C. C. Sanborn of the Chicago Natural History Museum for very helpful advice and for the use of the facilities of the Division of Mammalogy.

Clethrionomys rutilus washburni, new subspecies

Type.—Adult male, skin and skull, collector's no. 784; deposited in the Chicago Natural History Museum; from Perry River, District of Mackenzie, Northwest Territories, Canada, latitude 67° 34′ North, longitude 102° 07′ West; taken July 2, 1949, by Harold C. Hanson.

Range.—Known only from the type locality in the extreme northeastern corner of the District of Mackenzie.

Diagnosis.—Largest of the known American races of *rutilus*; skull measurements average larger in all dimensions than in a series of ten adults from Atlin, British Columbia, considered by Orr (1945) to be almost topotypical specimens. Differs from *dawsoni* and other races of *rutilus* in having a notably greater crown length of the maxillary tooth row. Tail short, averaging only 26.9 mm. in length as compared with 35.8 mm. given by Orr as the average for the ten Atlin, B. C., specimens. Hair of underparts of the entire Perry River series (nine specimens) tipped with white—not washed with ochraceous buff to light buff as in the case of *dawsoni*; white of underparts extends up the side of the head to a line extending back from the level of the upper lip. Dorsal surface of feet whitish rather than buff, tan, or even slaty brown as in the case of the various specimens of *dawsoni* examined. Tail grizzled in appearance, general color being buffy-tan, not a darker, more reddish brown as in *dawsoni*; variation in color of back comparable to that in *dawsoni*, but sides of body and head a lighter more buffy tan than in *dawsoni*.

Measurements.—The average and extreme measurements of seven adults from Perry River are given in Table 1. The larger size of the females should be noted, a not uncommon occurrence in microtine rodents. Thus the sex ratio in a series of specimens of this species influences "average size of adults."

For the purpose of comparison, the measurements given by Orr (1945) for the ten adults from Atlin, B. C., are listed: total length, 140.4 (130–151); tail, 35.8 (31–44); hind foot, 19.8 (19–21); condylo-basal length, 9 averaged, 24.2 (23.4–24.8); zygomatic breadth, 13.4 (12.4–14.1); length of nasals, 7.6 (7.3–8.0); breadth of brain case superior to auditory meatus (9 averaged) 10.1 (9.7–10.7); crown length of maxillary tooth row, 4.9 (4.7–5.0). Preble (1908) has summarized the average external measurements of seven series of adult *dawsoni* from as many localities in western sections of the District of Mackenzie (Ft. Rae, Lake St. Croix, Ft. Franklin, Ft. Simpson, Ft. Norman, Ft. Good Hope, and Ft. McPherson).

TABLE 1.—*Measurements (mm.) of Clethrionomys rutilus washburni from Perry River, District of Mackenzie, N. W. T., Canada*

COLLECTOR'S NUMBER	SEX AND AGE	DATE, JULY	WEIGHT (GMS.)	TOTAL LENGTH	TAIL	HIND FOOT	CONDYLO-BASAL LENGTH	ZYGOMATIC BREADTH	BREADTH OF BRAIN CASE	LENGTH OF NASALS	CROWN LENGTH, MAXILLARY TOOTH ROW
785	M ad	2	30.5	135	26	19	25.0	—	11.0	—	5.4
789	M ad	3	36.8	144	27	18	—	15.0	11.4	—	5.3
797	M ad	12	—	135	27	17	—	—	—	7.2	5.3
Average males			33.6	138	27	18	25.0	15.0	11.2	7.2	5.3
794	F ad	9	—	147	28	18	25.9	15.0	11.3	8.2	5.4
795	F ad	9	—	148	25	17	—	14.6	—	8.0	5.6
799	F ad	14	—	149	25	18	25.5	15.3	—	7.6	5.5
804	F ad	22	40.3	147	30	19	—	—	—	8.3	5.4
Average females				148	27	18	25.7	15.0	11.3	8.0	5.5
805	M s ad	22	—	117	25	16	—	—	—	—	—
806	M s ad	24	—	117	26	17	21.6	—	10.3	6.3	4.5

Remarks.—Clethrionomys rutilus probably ranges over most of the entire barren grounds of Canada west of Hudson Bay, wherever suitable habitat is found. Preble (1908) has summarized localities in the western range of *dawsoni* in detail, and Orr (1945) has given the ranges of other races. Clarke (1940) and Banfield (1955) cite a number of other locality records. Sutton (1931) caught a red-backed vole, presumably this species, at Tavani on the coast of Hudson Bay. The present series of *rutilus* from Perry River extends the recorded occurrence of this species by about 300 miles northward in the eastern part of its range, the nearest known locality to the south being Baker Lake. Gavin (1945) evidently did not find red-backed voles in the Perry River area, but reported a species of *Microtus* as occurring there. We found no evidence that *Microtus* occurs at Perry River, and since Gavin did not bring back specimens, he may, relying on memory, have confused the two species.

The present race, being larger in body size, with shorter tail, somewhat shorter feet, generally lighter in coloration and occupying the more northerly and colder and drier sectors than other races, is in accord with the rules of Bergman, Gloger, and Allen.

While the race *washburni* appears to be a particularly well-marked one, it would seem not improbable that adequate collections from areas to the south and west of the type locality may reveal that it intergrades imperceptibly with *dawsoni—washburni* being but an extreme on a cline. Although the barren grounds are chiefly a low peneplain possessing no geographic barriers of note, in the case of this vole the large lakes in the Back River system lying about 120 miles to the southeast may form a fairly formidable barrier between *washburni* and populations inhabiting the country south of these lakes.

Specimens examined.—Total number, 22 skins and skulls. Alaska: Kenai Peninsula, Seldovia, 1; Moose Camp, 1, and mountains near Eagle, 2 (Chicago Natural History Museum), District of Mackenzie: Ft. McPherson, 2; Ft. Good Hope, 3; Great Bear Lake, Leith Point, 2; Ft. Norman, 2; Ft. Simpson, 2; Ft. Rae, 2; Aylmer Lake, 2; Nahanni River Mts., 2 (U. S. National Museum). Manitoba: Nonala, 1 (University of Minnesota Museum of Natural History).

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HAROLD C. HANSON, *Illinois Natural History Survey, Urbana, Illinois.* *Received February 28, 1952.*

CITELLUS SPILOSOMA MAJOR MERRIAM, PREOCCUPIED

The name *Citellus spilosoma major* Merriam, 1890, is preoccupied by *Citellus major* Pallas, 1778 (see Ognev, The mammals of Russia [USSR] and adjacent countries. vol. 5, p. 46, 1947). *Citellus spilosoma marginatus* Bailey, 1902, is available for this race of ground squirrel and replaces *major* of Merriam (see Howell, N. A. Fauna, no. 56, p. 126, 1938).—William P. Harris, Jr., *Museum of Zoology, University of Michigan, Ann Arbor,* *Received May 6, 1952.*

A NEW NAME FOR *MIRANDAIA RIBEIROI* PAULA COUTO, 1952

In my paper about the "Fossil Mammals from the beginning of the Cenozoic in Brazil—Marsupialia: Didelphidae" (Amer. Mus. Novitates No. 1567, June 5, 1952, pp. 22–23) I proposed the name *Mirandaia ribeiroi* for a new genus and a new species of didelphid from the Paleocene (Itaboraian) of São José de Itaborai, State of Rio de Janeiro, Brazil.

As the name *Mirandaia ribeiroi* Paula Couto, 1952, is preoccupied in Nematodia by *Mirandaia ribeiroi* Travassos, 1937 (Revisão de família Trichostrongylidae Leiper, 1912. Mongr. Inst. Oswaldo Cruz, No. 1, 1937, p. 360) I hereby propose the new name *Mirandatherium alipioi* to replace *Mirandaia ribeiroi* Paula Couto, 1952, *nec.* Travassos, 1937.—Carlos de Paula Couto, *Museu Nacional, Rio de Janeiro, D.F., Brazil.*

REVIEWS

Hall, E. Raymond. American Weasels. Univ. Kansas Publ., Mus. Nat. Hist., Lawrence. Vol. 4; pp., 466; pls., 41; figs. in text, 31. December 27, 1951.

The publication of this revision of the American weasels (genus *Mustela*) culminates some twenty-five years of study by the author. During this time, he examined every specimen of American weasel available to him (in foreign as well as domestic collections), collected and studied them in the wild, and brought live animals into the laboratory for observation. The author apologizes for taking so long to complete the study, but he need not do so because not all of his time, during those twenty-five years, was spent on the weasel monograph; this is self-evident from the many publications on various mammalogical subjects which have been issued under his name.

Hall starts out by giving a concise paleontological history of the genus *Mustela*. This is followed by short discussions of the skeleton and teeth, a rather longer account of variation in the group (age, sexual, individual, seasonal, coloration and molt, and variations of taxonomic worth), distribution and speciation, and a history of the classification of the American weasels. There then follows the taxonomic part of the revision proper, introduced by an artificial key to all of the American species of the genus *Mustela*.

At the beginning of the account of each of the four species considered, he gives a summary of information on food habits, behavior, enemies, reproduction, and other pertinent material on life histories. The subspecies are treated in uniform fashion throughout the text, with synonymy, data for the holotype, range, characters for ready recognition, descriptions (size, color, skull), comparisons, general remarks, and specimens examined, in that order. Range maps are included for all subspecies, making some of the descriptions of range seem like unnecessary duplication.

Following the accounts of the subspecies, and species, is an explanation of cranial measurements (with diagrams of the skull), a tabulation of selected measurements of selected skulls, an extensive list of literature, numerous halftones (chiefly of crania), and an abbreviated but adequate index.

To review some of the sections more in detail, that on the skeleton is chiefly on variation in numbers of vertebrae. The cervicals are the only ones that are constant. The thoracics, lumbars, and sacrals vary in numbers by one or two; it is in the caudals where the greatest

variation occurs—15–19 in *erminea*, 11–16 in *rixosa*, and 19–63 in *frenata*. Some of this variation seems to be geographic in nature. The teeth, deciduous and permanent, are described briefly, and their flesh-eating adaptations are pointed out.

There are about twice as many males as females represented in zoological collections. Hall attributes this to the greater area covered by the male (increasing his chance over that of the female in encountering a trap) and the lesser weight of the female (she might have insufficient weight to spring the trap in every instance).

The section on "Variation" is of a descriptive and general nature. I suspect that the author considered his samples too small to subject them to statistical analysis. The subsection on "Variations of Taxonomic Worth" contains a discussion of geographic variation. If variations in certain structures show trends geographically (clinal in nature), he considers them to be of taxonomic worth. Demonstrable intergradation (on the mainland) and/or degree of difference (on islands) are used as criteria for designating subspecies, as contrasted to species, in the weasels.

In the section on "Distribution and Speciation," Hall speculates on former distributions and on the way that the different species of weasels reached the areas they now occupy. He considers *erminea* to be the most generalized of the full species, and perhaps "nearest the stem form from which all of the living weasels ascended [*sic*]." (p. 55). The most advanced, structurally, of the American weasels, he thinks, is *frenata*. Within the species *frenata*, he considers those subspecies which occur in the tropics to be more primitive than those of the temperate region, and *africana*, a South American species, is ". . . the most primitive of the American weasels." (p. 59). Yet, on page 55, we were told that ". . . it is possible to think of these other species as derived from *M. erminea*." Further, in Fig. 23, p. 61, he shows the main stem as of *erminea* stock. First to branch off from this stem is *rixosa*, followed by *africana* and then *frenata*. This reviewer finds it difficult to follow this part of his discussion, or to understand the precise implication of the following statements on page 62. "*M. erminea* in almost every one of its characteristics is generalized and potentially progressive whereas *africana* retains more characters which are truly primitive along with a few which are specializations. *M. africana* is potentially the least progressive of any of the American weasels." Generalized, it seems to me, is here used an an antonym of primitive. My concept of the meanings of the two terms would not permit this usage. I assume that the author, in speaking of a "progressive species," means one that is plastic, that is adaptable to diverse and changing conditions, one that has not become specialized. If so, I am in agreement. The last part of the last paragraph of this section (p. 69) also causes me to wonder. After stating that much of the change (evolution) in the American weasels "probably is the result of natural selection operating on fortuitous variations of a minor nature," he goes on to say "but, also, particular features of the environment, especially climate, and more especially amount of rainfall, seem to compel variations that differentiate subspecies and that characterize full species—compel some of them without the direct operation of natural selection, or at least compel them within limits so wide that natural selection exerts no exact control." I should like to have had an explanation of the mechanism by which "climate, and more especially amount of rainfall" could "compel" heritable variations that "differentiate subspecies and that characterize full species. . . .without the direct operation of natural selection," if that be the intended meaning of the statement quoted above.

Concerning the bulk of the work, the systematic accounts of the species and their subspecies, I feel that I am in a position to comment only on his treatment of Michigan material with which I have a vague familiarity. On this, I should like to comment only on his treatment of *erminea*. With four specimens as a basis, he places all of the Lower Peninsula within the range of *bangsi*, a subspecies that occurs to the west of Michigan. This indicates western affinities for the population of *erminea* in the Lower Peninsula. If true, this is in contrast to the way most other subspecies of mammals behave in our area; their affinities are definitely in other directions. Based on materials in the Museum of Zoology collections, and without the benefit of Hall's extensive knowledge of the weasels as a group, my conclusions from a cursory study of our specimens are: The population of *erminea* from the Lower Penin-

sula and most of the Upper Peninsula, including Isle Royal, should be known as *cicognani*, at least until sufficient material has accumulated to prove unquestionably that they are something else. Along the western edge of the Upper Peninsula, the population shows intergradation between *cicognani* and *bangsi*, and might equally well be placed with one or the other. Hall mentions that the Isle Royal material does not conform to pattern. Zoogeographically, Isle Royal is part and parcel of the Canadian mainland to the north, not, most certainly, of the Lower Peninsula of Michigan.

In any work of this magnitude there are usually a few errors. Dr. Hall (*in litt.*) has kindly furnished me with the following corrections that should be made. In line four of page 62, "figure 16" should read figure 23; in the last two lines of page 221, the words *africana* and *stolzmanni* are transposed; in line 39 of page 280, "western Washington" should read eastern Washington; on page 320, the holotype of *M. f. nigriauris* is erroneously given as No. 32820 from Half Moon Bay, it is actually No. 70210 from 2½ miles east of Santa Cruz, as given in the original description.

In addition to the above, I offer the following: On page 13, Table 1, he uses both "thoracic" and "dorsal" to designate rib-bearing vertebrae. Inasmuch as the terms are used in separate columns, the uninitiated might think that they represent two categories of vertebrae. On page 71, "Joseph A. Allen" should read Joel A. Allen. "Hudson's Bay" is used throughout the text; most modern atlases give it as Hudson Bay. On page 200, "*Vulpes fulvus*" should read *Vulpes fulva*. The table of cranial measurements (p. 418) starts off in a rather confusing manner. At the head of column one is "Collection," but the first items below are "average, maximum, minimum." Under "Catalogue number" one finds sex and age, and under "Sex and age" he finds number of specimens. A slight re-arrangement of the table would have been advisable. The explanation of cranial measurements (p. 417) does not include "postglenoid length of skull," which is used prominently in the key on page 83.

There are a few misspellings scattered through the text, but none of those I noticed are serious. Obviously, different parts of the monograph were written at different times. Some parts read off smoothly, and are well written, while other parts are somewhat stilted and badly punctuated. A profusion of misplaced commas does not add to the clarity of expression. More careful editing of the finished manuscript would have made for greater uniformity throughout the volume. These, however, are minor criticisms. The work is a valuable one, and will long be a standard reference for anyone concerned with studies on weasels.—William H. Burt.

Williams, Jay P. Alaskan Adventure. Harrisburg, Pa., The Stackpole Company, xiii + 299 pp.; illus. in sepia halftone with decorative map. Price, $4.50.

This volume of thirteen chapters and two of appendix, one of which deals with equipment and technique for "Camp and Trail," and the other "The Alaskan Packboard and the Hunters Leanto Tent" designed by Col. Townsend Whelen, internationally famous big game hunter, author and lecturer, will long remain one of the best books concerning Alaska.

Jay P. Williams, now living in retirement at Eugene, Oregon, first went to Alaska soon after the turn of the century as a prospector, trapper, horse wrangler, a member of the Alaska Boundary Survey, then followed by thirty years in the U. S. Forest Service in that territory, has brought together between the covers of a book Alaska's out-of-doors as has no other individual. His phraseology, clearness of description, and wit are of the kind that once the reader begins to peruse the volume, there is no laying it aside for some other time.

I know of no running account that describes in such detail the natural history concerning Alaska's grizzlies and brown bears, and the reasons why there be need for constant alertness when dealing with these large mammals. Williams has between 150 and 200 grizzly and brown bears to his credit, taken under all sorts of conditions, trials, and excitement. As the story is unfolded one feels the impact of his experiences, and in some instances, a mere split minute might have resulted in tragic results to himself or partner.

His chapter on the Rocky Mountain goat, in the opinion of this reviewer, contains the best natural history on this animal yet in printer's ink. The illustrations are all not only

outstanding and clear, but rather convey minute details of Alaskan habitat of our larger land mammals as found there.

Jay Williams joined the Alaskan Boundary Survey in May of 1904, eventually retired from the U. S. Forest Service, Alaska Region, after 30 years service, and then for several years was a sportsmen's guide in Alaska. For the student of natural history, mammalogy, or wildlife photography, and for a real good "look see" into frontier Alaska as Williams found it, this volume is a bargain at any price.—STANLEY P. YOUNG.

RECENT LITERATURE

(Conducted by G. S. Miller, Jr., Emma Charters, D. H. Johnson, and R. H. Manville)
[Reprints of this section may be purchased from the Corresponding Secretary]

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COMMENT AND NEWS

NEW EDITOR TAKES OVER

With this issue, I end a five-year period as editor of your Journal. When I look back on those five years, I am impressed most by the wonderful co-operation I have received from my editorial committee and from you as authors. Without that fine spirit, it would have been a real chore, but with it, I can assure you, it was a challenge and a pleasure. I hope that you will be kind enough to overlook some of the mistakes I have made, also, I hope that you will be appreciative of the many hours that the editorial committee spent in your behalf. The Journal now goes over to our new editor who, I am convinced, will do a much better job than I did, and I know that you will give Dr. Eadie the same splendid co-operation that I have enjoyed.—WILLIAM H. BURT.

NEW SOCIETY FOR MAMMALIAN RESEARCH

On February 19, 1952, at the Zoological Museum of Amsterdam, the Society for Mammalogical Research for Belgium, the Netherlands, and Luxemburg was founded. The first general meeting of the Society was held at the Zoo of Rotterdam on May 17, 1952. Officers were elected as follows: President, Mr. F. H. van den Brink, Leiden; vice-presidents, Prof. Dr. G. Vandebroek, Louvain, and Prof. Dr. E. J. Slijper, Amsterdam; secretaries-treasurers, Dr. A. Scheygrond, Gouda, and X. Misonne, Brussels; directors, Ir. F. J. Appelman, The Hague, W. Van den berg, Antwerp, Dr. S. Frechkop, Brussels, M. Heuertz, Luxemburg, Ir. A. J. Ophof, Wageningen, and Mr. J. O. Thate, Gorsell. The second meeting of the Society was scheduled for October, 1952, at Antwerp.

DATE OF ISSUE OF PREVIOUS NUMBER

Journal of Mammalogy, Vol. 33, No. 3, was mailed **August 19, 1952**

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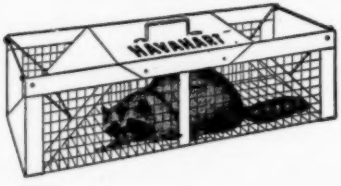

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